CLAIMS

(57) [Claim(s)]
[Claim 1] The gas inlet for introducing the gas containing gaseous pollutants, such as nitrogen oxides and a sulfur oxide, which should be purified, To the gas passageway in casing equipped with the gas outlet for discharging the gas after clarification The corona electrode system which consists of the independent electrode of two or more arrangement **** after insulating mutually as a counterelectrode which countered the piece with the corona discharge pole and countered other pieces with this corona discharge pole at least is prepared. The capacitive energy are recording element for impressing the very short ultrashort pulse high tension of pulse width between this corona discharge pole and other electrodes, In the gas cleanup equipment of the place in which the high voltage ultrashort pulse power source which consists of the power source for charge and the high-speed switch element for discharge was prepared When relative density of the gas in the temperature and the atmospheric pressure at the time of purifying said gas when setting pulse width of this high voltage ultrashort pulse power source to 1 or less microsecond, and setting the consistency of the gas in 0 degree C and 1 atmospheric pressure to 1 is set to d, If distance-average field strength between this corona discharge pole that shows the critical value for making a large quantity generate chemical active species (radical) for the peak value electrical potential difference **** of the ultrashort pulse high tension to impress between said corona discharge poles and counterelectrodes, and this counterelectrode is set to Epo Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by making it become Epo=more than 8d (kV/cm).
[Claim 2] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this capacitive energy are recording element being a capacitor in equipment given in a claim (1).
[Claim 3] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this capacitive energy are recording element being a high voltage coaxial cable in equipment given in a claim (1).
[Claim 4] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this capacitive energy are recording element being LC ladder mold connection circuit of two or more capacitors and an inductance, respectively in equipment given in a claim (1).
[Claim 5] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this high-speed switch element for discharge being a revolution spark switch in equipment given in either to (4) from a claim (1).
[Claim 6] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this high-speed switch element for discharge being a fixed spark discharge switch in equipment given in either to (4) from a claim (1).
[Claim 7] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being the 2 electrode system to which this corona electrode system changes only from a corona discharge pole and a counterelectrode to either to (6) in the equipment of a publication from a claim (1), and these other electrodes being counterelectrodes.
[Claim 8] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this counterelectrode being a non-corona electrode in equipment given in a claim (7).
[Claim 9] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being the corona discharge pole where this counterelectrode performs corona discharge to a claim (7) in the equipment of a publication.
[Claim 10] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being the 3 electrode system in which it insulates from two electrodes near this corona discharge pole besides a corona discharge pole and a counterelectrode, and this corona electrode system has the third electrode of arrangement **** in equipment given in either to (6) from a claim (1).
[Claim 11] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by having a direct-current high voltage power supply for impressing direct-current high tension to a claim (10) between this third electrode and this counterelectrode in the equipment of a publication, and impressing this ultrashort pulse high tension between this corona discharge pole and this third electrode as these other electrodes.
[Claim 12] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this third electrode being a non-corona electrode in equipment given in a claim (10) or (11).
[Claim 13] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being the corona discharge pole where this third electrode performs corona discharge in the equipment of a publication to a claim (10) or (11).
[Claim 14] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by preparing the bias high voltage power supply for impressing bias high tension to either to (13) beforehand between this corona discharge pole and these other electrodes in the equipment of a publication, and impressing this ultrashort pulse high tension of this and like-pole nature to this bias high tension between two electrodes through a coupling capacitor in piles from a claim (1).
[Claim 15] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this bias high voltage power supply being a direct-current high voltage power supply in equipment given in a claim (14).
[Claim 16] Ultrashort pulse high-tension **** type gas cleanup equipment of the place where this bias high voltage power supply is characterized by being the source of bias pulse height piezo-electricity of the place which generates the pulse height electrical potential difference for bias which has width longer enough than the mesial magnitude width of this ultrashort pulse high tension in equipment given in a claim (14).
[Claim 17] In equipment more nearly given in either to (16) than a claim (1) It is more than one half of the geometric die length of this ultrashort pulse high tension where at least one die length in this corona discharge pole, this counterelectrode, and these other electrodes spreads a it top at least as this corona electrode system. And ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by using the corona transmission line where the termination is opened.
[Claim 18] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by inserting the coil for peaking in a claim (17) in the equipment of a publication in at least one or more midpoints of an electrode with at least one long die length

which constitutes this corona transmission line.
[Claim 19] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being ******** to which the overall length of this corona transmission line is divided into two or more partial lines, and the partial line except the partial line of the down-stream edge changes from the parallel connection **** thing of two or more corona discharge poles to a claim (17) in the equipment of a publication, and the corona discharge pole of the parallel connection decreases serially toward a down-stream edge from an upper edge.
[Claim 20] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being the corona electrode for **** peaking with which this corona discharge pole is beltlike with an electrode, and reduces the width toward termination in equipment given in either to (17) from an input edge from a claim (1).
[Claim 21] the line with a more nearly circular corona discharge pole [this] than a claim (1) cross section in equipment given in either to (19) -- the ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being a corona discharge pole.
[Claim 22] equipment more nearly given in either to (19) than a claim (1) -- setting -- this corona discharge pole -- a cross section -- a polygonal line -- the ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being a corona discharge pole.
[Claim 23] equipment more nearly given in either to (19) than a claim (1) -- setting -- this corona discharge pole -- a cross section -- a stellate line -- the ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being a corona discharge pole.
[Claim 24] equipment more nearly given in either to (19) than a claim (1) -- setting -- the line of a strip [pole / this / corona discharge] -- the ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being a corona discharge pole.
[Claim 25] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this corona discharge pole being a projection finishing line-like corona discharge pole in equipment given in either to (19) from a claim (1).
[Claim 26] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this corona discharge pole being a projection cylindrical corona discharge pole in equipment given in either to (19) from a claim (1).
[Claim 27] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this corona discharge pole being a projection strip corona discharge pole in equipment given in either to (19) from a claim (1).
[Claim 28] In equipment more nearly given in either to (27) than a claim (1) As more than the geometric die length of this ultrashort pulse high tension that connects this ultrashort high voltage pulse power source and this corona electrode system with a high voltage coaxial cable, and spreads the die length of this coaxial cable on it at least Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by giving this an operation of the transmission line for separation.
[Claim 29] It sets from a claim (1) to equipment more nearly given in either to (28) than (10) to (8). This corona discharge pole and this counterelectrode are the discharge electrodes and collecting electrodes in an electrostatic precipitator, respectively. This casing The hopper for [the] accepting a collection particle caudad, Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by having an exhaust port for discharging this outside, and performing electrostatic precipitation of the particle in gas in addition to clarification of exhaust gas.
[Claim 30] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by forming the hammering equipment for giving either to (29) a mechanical shock in this corona discharge pole and a counterelectrode in the equipment of a publication at at least 1 person from a claim (1).
[Claim 31] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by arranging this corona electrode system in casing of an electrostatic precipitator in the equipment of a publication at either to (30) from a claim (1).
[Claim 32] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by providing a means to form liquid membrane in this counterelectrode thru/or a dust collection front face in the equipment of a publication at either to (31) from a claim (1).
[Claim 33] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by equipping the gas which should be this purified from a claim (1) in the equipment of a publication to either to (32) with the agent feeding equipment for adding the additive for reaction acceleration beforehand.
[Claim 34] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this agent feeding equipment being an ammonia injection equipment in equipment given in a claim (33).
[Claim 35] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by equipping the gas which should be this purified from a claim (1) in the equipment of a publication to either to (34) with the gas pre-treatment equipment for pretreating beforehand.
[Claim 36] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this gas pre-treatment equipment being a gas cooling tower in equipment given in a claim (35).
[Claim 37] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by having gas after-treatment equipment for carrying out after treatment of the gas after clarification to either to (36) further in the equipment of a publication from a claim (1).
[Claim 38] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by being a gas absorber for absorbing the gas after this gas after-treatment equipment reacting in equipment given in a claim (37).
[Claim 39] Ultrashort pulse high-tension **** type gas cleanup equipment of the place characterized by this gas after-treatment equipment being a dust collector in equipment given in a claim (37).

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Industrial Application]
This invention relates to the "ultrashort pulse high-voltage **** type gas cleanup equipment" for removing various kinds of gaseous pollutants which contain these by **, such as oxidation and disassembly of the nitrogen oxides (it calls Following NOx) contained in the industrial exhaust gas from a boiler, a sintering machine, etc., and oxidation of a sulfur dioxide (it calls the following SO 2). However, the application range can be used, also in order not to remain in a mere gas cleanup, but to be able to collect dust to a gas cleanup and coincidence, to be able to use for decomposition of NOx generated with the equipment which uses corona discharge, such as an electronic copying machine and an electric discharge machine, etc. combining philharmonic a **** type bug [an electrostatic precipitator and] etc. and for the discharge chemistry-reaction in gas to perform effectively oxidation of specific gas constituents, reduction, generation, decomposition, etc. generally.
[Description of the Prior Art]
Conventionally, it is the chemical approach which is used for denitrification and desulfurization of exhaust gas chiefly. The so-called "ammonia catalytic reduction approach which mainly decomposes NOx into nitrogen and moisture with the upper catalyst of addition of ammonia in exhaust gas with the gas temperature of 300 degrees or more is used for denitrification. Moreover, milk of lime is mainly made desulfurization at the shape of Myst, and the so-called "limestone fat method" which absorbs SO2 to this and is removed from gas as sulfurous-acid gypsum fibrosum is used after distributing in exhaust gas. On the other hand, the ammonia addition-top was irradiated at exhaust gas, the electron beam of high energy was irradiated beforehand at this, NOx and SO2 were converted into the solid-state particle of ****** double salt, and the "electron beam emission-gas-purification method" which removes this from gas was developed. Moreover, electric field are added for this method to the exposure space of an electron beam, and that effectiveness is proved also for how to improve by gathering that reaction rate. Furthermore, only the corona electrode system which only consists of a corona discharge pole and a non-corona counterelectrode is prepared into exhaust gas, a pulse height electrical potential difference is applied between two electrodes, the method which performs denitrification and desulfurization is also proposed, and the effectiveness in the equipment of a laboratory scale is proved. However, utilization is very difficult for each of these, and they has resulted in current as they does not succeed in utilization.
[Problem(s) to be Solved by the Invention]
The chemical approaches, such as the above-mentioned "ammonia catalytic reduction method" and a "limestone fat method", have very high construction cost and running cost, and have problems, such as corrosion of the upper equipment, and a life of a catalyst. Denitrification and desulfurization can be performed to coincidence, as for the "electron beam emission-gas-purification approach", a catalyst is not needed, either, but although equipment is easy and maintenance is also easy equipment since it is a perfect dry type process, an installation cost and running cost need an expensive cure for radiation protection a both very high top. Since there is no change in the method which adds electric field to the exposure space of an electron beam by this method, and promotes denitrification and desulphurization reaction using an electron beam fundamentally, becoming [of an installation cost] high is not avoided. An after all the easiest and economical approach is an approach prepare only a corona electrode system into exhaust gas, impress periodically a pulse height electrical potential difference with short width of face between two electrodes, generate pulse-corona discharge, and this performs desulfurization and denitrification of exhaust gas, or other purification in pure electrical and electric equipment. However, with equipment also with this large-sized, it was admitted that that effectiveness did not exist and the actual condition was that the policy for putting this method in practical use is not being formed at all.
This invention aims at conquering the above-mentioned difficulty and putting "the gas cleanup method using the corona discharge by the ultrashort pulse high voltage" in practical use with large-sized equipment.
[Means for Solving the Problem]
This invention in the gas containing the gaseous pollutant of NOx and SO2 grade The corona electrode system which changes mutually from the independent electrode of two or more upper arrangement **** of an insulation as a counterelectrode which countered the piece with the corona discharge pole and countered other pieces with this corona discharge pole at least is prepared. In the equipment which aims at denitrification and desulfurization of gas by impressing the very short ultrashort pulse high voltage of pulse width between this corona discharge pole and other electrodes When making pulse width of the ultrashort pulse high voltage into the value for 1 or less microsecond and setting relative density of the gas in the temperature and the pressure at the time of the purification to the consistency of the sewer gas-ed in 0 degree C and 1 atmospheric pressure to d, Critical value Epo=8d in which the time peak value Ep of the distance-average field strength which shows the peak value electrical potential difference **** per unit length between this corona discharge pole and this counterelectrode triggers a gas cleanup reaction at least (kV/cm) .... (1)
********** which becomes the above -- the above-mentioned trouble is solved by selecting the value of the peak value electrical potential difference **** to a high value.
Here, by this application, although a "electrical potential difference" means the thing of the peak value of a pulse, or peak value, in order to distinguish, for example from the electrical potential difference in the standup part of a pulse etc., it is expressed as peak value (peak value).
Moreover, the economical strength of the electric field which exist as everyone knows in the magnetic field which changes to the surrounding field strength or surrounding ** time amount target of the charge in ** electrostatic field is expressed as average field strength. Since the average field strength stated by this application means the field strength of ** (here, it works to inter-electrode), i.e., the field strength of the point which kept a fixed distance from the charge, distance-average field strength [field strength] has been written so that it may not mix up with the electric field of **.
Namely, this invention person crosses the gas passageway of the gas containing NOx and SO2 grade, and makes pulse-corona

discharge generate. ********** which has the distance-average field strength [good] in the gap for Epo of the above-mentioned conditions (1) at least -- a high value and by taking the value more than 12d (kV/cm) preferably for the first time -- NO and SO2 -- NO2 and SO3 of water solubility respectively -- it can oxidize -- a suitable absorbent thru/or a lean solution, for example, water, and NaOH and Na2 -- it found out that it was effectively removable out of gas with the contact absorption to the water solution or suspension water of CO3 and calcium (OH)2 and CaCO3. In this case, if the lean solution of this NO2 and SO3 grade makes the front face of this counterelectrode flow down in the form of liquid membrane, it is effective and the most suitable. Moreover, although NO2 generated by oxidation of NO was further decomposed in the operation of pulse-corona discharge by the ultrashort pulse high voltage, it was found out by adding NOx and equivalent ammonia in gas beforehand in this case that decomposition of NO2 is promoted remarkably. Moreover, it was found out that inversion immobilization also of SO2 or SO3 is carried out by addition of ammonia at a solid-state particle. Moreover, when NOx and SO2 lived together in gas, when using a forward pulse corona, oxidation and decomposition of NOx preceded first, and it became clear that oxidation of SO2 was performed after an appropriate time. Moreover, the mercury vapour contained in gas also oxidizing very effectively by the above-mentioned pulse-corona discharge, and serving as a solid mercury oxide, and becoming the mercury chloride of fusibility under existence of HCL etc. is known.
Moreover, the more discharge chemistry-gas cleanup reactions by this invention, such as oxidation of NO, decomposition of NO2, oxidation of SO2, oxidation of mercury vapour, and chlorination, make still higher distance-average field strength between the corona discharge pole in a gas passageway, and a counterelectrode exceeding Epo of the above-mentioned (1) formula, the more Moreover, it also became clear that it was carried out more effectively, so that it made small the radius of curvature of a corona discharge pole, or it attached the sharp projection, and pulse corona discharge was closed, if.
It is necessary to shorten extremely width of face of the above-mentioned ultrashort pulse high voltage which should impress the remarkable high distance-average field strength exceeding Epo of the above-mentioned (1) formula to forming without generating of a spark in the corona space of the above-mentioned gas passageway. In this case, although it depended for that necessary value on the configuration, the electrode configuration and the dimension of the corona electrode system to be used, a presentation, temperature, a pressure of gas, etc. when pulse width was expressed with the mesial magnitude width Tp, it was usually found out by the experiment that it is necessary to make Tp for it to be desirable and short to 500 or less ns and the degree of pole 1000 or less ns even if long.
The 3 electrode system which could use the 2 electrode system which consists of two kinds of independent electrodes, this corona discharge pole and this counterelectrode, which are used for this invention, and which separated the gas passageway as a corona electrode system, and countered mutually, and carried out insulating arrangement of the third electrode further near the discharge electrode may be used. moreover -- as this corona discharge pole used for this invention -- a line -- the shape of a - square wire, and with a prickle -- a line -- although the thing of what kind of the suitable configuration, structure, and quality of the materials, such as cylindrical with - projection, a strip, and a strip with a projection, may be used, since a discharge chemistry operation becomes flourishing so that it is made a configuration which corona discharge starts actively as above-mentioned, generally it is suitable. Moreover, even if it fixes and uses this corona discharge pole for a suitable housing, the one long corona transmission line is made to form, and you may use.
When using the above-mentioned 2 electrode system as an electrode configuration of this invention, the above corona discharge poles may be used as the counterelectrode, and a non-corona electrode with the big radius of curvature of the shape of tabular and a wire gauze and cylindrical ** may be used. Moreover, when using a 3 electrode system, it is suitable to use the above non-corona electrodes as a counterelectrode, and it can also use any of a corona discharge pole and a non-corona electrode as the third electrode. Although this ultrashort pulse high voltage may be directly impressed between this corona discharge pole and a counterelectrode in use of a 2 electrode system The pulse height electrical potential difference and the auxiliary high voltage (it is called the bias high voltage below) of like-pole nature which should be beforehand applied between two electrodes are applied. If this ultrashort pulse high voltage is impressed to this through a coupling capacitor in piles, the ultrashort high-pressure pulse power source for only the part of this bias high voltage being able to reduce the peak value electrical potential difference, and generating the ultrashort pulse high voltage can be made cheap, and it is suitable.
If in charge of use of a 3 electrode system, between this third electrode and this counterelectrode, the above-mentioned bias high voltage is impressed, as the polarity over the former latter becomes the same as the polarity in this pulse height electrical potential difference of this corona discharge pole, and this pulse height electrical potential difference is impressed through direct or a coupling capacitor between this corona discharge pole and this third electrode on it.
Although the above-mentioned bias high voltage used in a 2 electrode system and a 3 electrode system may use the direct-current high voltage, if a pulse height electrical potential difference with width of face wider than this ultrashort pulse high voltage (it is called below a bias pulse height electrical potential difference) is used, unlike the case where the bias direct-current high voltage is used, the ion current which crosses gas-passageway space and flows can be reduced sharply, and the power consumption which gas cleanups, such as denitrification and desulfurization, take can be reduced remarkably.
When this counterelectrode is used as a non-corona electrode in the above-mentioned 2 electrode system and a 3 electrode system, Although the polarity of this corona discharge pole at the time of impressing the ultrashort pulse high voltage may be - [forward] Undertaken and you may be a gap, since a forward pulse corona is extended in the shape of a streamer and bridges this corona discharge pole and partner inter-electrode gas space The chemical active species which becomes the basis which makes gas cleanup reactions, such as denitrification and desulfurization, occur can be generated by the whole space, can complete this reaction in the comparatively small equipment volume thru/or the short paddle residence time, and can miniaturize a facility. Therefore, the direction which used forward pulse corona discharge for carrying out this invention independently for the purpose of only gas cleanups, such as denitrification, desulfurization, etc. of gas, can make an installation cost cheap. Since especially the oxidation rate to SO3 of SO2 is very slow in a negative pulse corona, it is necessary to use a forward pulse corona.
However, the corona electrode system of this invention is made to serve a double purpose as an electrostatic precipitator, this corona discharge pole is made as the discharge electrode, this counterelectrode is made into the dust collecting electrode, it is also possible to collect dust to a gas cleanup and coincidence, such as denitrification, desulfurization, etc. of exhaust gas, the ultrashort pulse high voltage is impressed by making the polarity negative in that case on this corona discharge pole, and it is suitable negative to carry out pulse corona discharge generating. It is because discharge bridges the gap between a corona discharge pole and a dust collecting electrode in the shape of a streamer, and acts to the whole gap space as Shigeo of forward and the anion like ****, when using forward pulse corona discharge, so the electric charge of the dust particle which needs bombardment of only unipolar ion cannot be performed but a dust collection operation is lost. On the other hand, if negative pulse corona discharge is used, discharge will be localized near the corona discharge pole, a forward anion will be formed only in this field, but since only an anion style exists in the other field, the electric charge and dust collection of dust may be performed effectively. In this case, when carrying out by making the electrostatic precipitator of 2 electrode types which consist this invention of a usual discharge electrode and a usual dust collecting electrode make it serve a double purpose, the electrode configuration of a corona electrode system is good to become the above-mentioned 2 electrode

system, to impress the direct-current high voltage which makes this corona discharge pole negative beforehand between two electrodes as a bias direct-current high voltage, and to impress this ultrashort pulse high voltage to this for this discharge electrode with the polarity made negative through a coupling capacitor in piles. Moreover, this invention can be carried out also as an electrostatic precipitator of 3 electrode types which prepared the third electrode which consists of a non-corona electrode thru/or a corona electrode near this corona discharge style in addition to a corona discharge pole and a dust collecting electrode, the direct-current high voltage which makes the former negative between this third electrode and this dust collecting electrode in this case is impressed, and this ultrashort pulse high voltage is impressed with the polarity which makes the former negative between this discharge electrode and the third electrode.

If the ultrashort pulse high voltage used by this invention constitutes a corona electrode system as the long transmission line (it is called the corona transmission line below), it can use most effectively the energy with which it generates covering the overall length, and this ultrashort pulse high voltage holds powerful corona discharge for gas cleanup reactions, such as formation of corona discharge, therefore denitrification, desulfurization, spreading a it top as a progressive wave. In this case, since that geometric die length becomes Lp=CoT when the width of a pulse voltage is T, since the propagation velocity of a pulse voltage is almost equal to the velocity of light Co, in the case of the corona transmission line of termination disconnection, it is ******** Lo>=(1/2) Lp from that that die length Lo is equivalent to Lp (1/2), or this. (2)

It is conditions for a ** pulse voltage to show the behavior as a progressive wave, and becomes the concentrated-constant load of the place where a corona electrode system consists of the equivalence parallel resistance of interelectrode capacity and corona discharge on the contrary at the time of Lo<<(1/2) Lp.

In carrying out the embodiment (it being called a progressive wave mold below) of this invention using this progressive wave with the corona electrode system of this 2 electrode system thru/or a 2 electrode type electrostatic precipitator It is suitable to have ****** 5 [about] thru/or 30cm in the shape of zigzag between the parallel touch-down **** tabular counterelectrodes (or dust collecting electrode) of a pair, and to carry out insulating arrangement of this linear long corona discharge pole. In this case, the touch-down counterelectrode (or dust collecting electrode) of the pair which faced mutually, and one long corona discharge pole arranged in that middle become a group, and constitutes the two corona transmission lines of juxtaposition. in this case, this corona discharge pole -- the earth -- insulating **** -- it is suitable to insulate from this to a suitable housing and to attach in it.

Moreover, in carrying out this progressive wave mold with the corona electrode system of a 3 electrode system, or a 3 electrode type electrostatic precipitator It is suitable to carry out insulating arrangement of either [at least] this corona discharge pole or this third electrode at the shape of zigzag with the spacing 2 [about] between this third electrode and a corona discharge pole thru/or 10cm in the middle of the parallel touch-down **** tabular counterelectrode (or dust collecting electrode) of the pair which faced mutually. In this case, this corona discharge pole, this third electrode, and this corona discharge pole and both counterelectrodes (or dust collecting electrode) form the three corona transmission lines (four [or]) of juxtaposition, respectively. in this case, the third electrode -- a drainboard -- it is suitable to consider as a form, to make it serve as a housing, to move in a zigzag direction so that the middle of the ****** perpendicular column of a drainboard may be run, and to arrange the this corona discharge pole after insulating from this housing in the shape of zigzag.

When the above-mentioned ultrashort pulse high voltage advances a corona transmission-line top as a progressive wave and corona discharge is carried out to the middle, for the energy loss accompanying it, the wave height part of this ultrashort pulse high voltage suffers a loss gradually, and goes, after [a certain] carrying out distance advance, the wave height section is lost completely, and the capacity which already produces corona discharge disappears. Although this distance changes with conditions, in the case of the intense forward pulse voltage [exhausting / which generates about 300m and powerful streamer-like corona discharge in the case of a negative pulse voltage / energy], it is about abbreviation 3m-10m. By the way, even after the wave height section disappears, this ultrashort pulse high voltage holds still more sufficient energy. In order to utilize this effectively, raise the wave height section again by a certain approach, and it carries out to beyond a corona-starting-voltage (this is called pulse peaking for short below) value. Converting the great portion of pulse height electrical-potential-difference possession energy into the energy of corona discharge raises the power efficiency of this method, it has lowered operation cost, and is very important. One approach for carrying out pulse peaking is a sardine IPI dance which is the corona transmission line.

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What is necessary is it to be good to make it so large that it go down-stream, and to make the inductance L per corona transmission-line unit length so large that it go down-stream, or just to make electrostatic capacity C between tracks per corona transmission-line unit length so small that it go down-stream for that purpose. The approach of carrying this out most simply in this invention is opening the termination of the corona transmission line (Zo's becoming infinite at this time and total reflection of the progressive wave being carried out) while making it so large that some inductance elements (it abbreviates to a peaking corona below) are inserted in the middle of a long corona discharge line and it goes that inductance value down-stream. Moreover, parallel connection of some discharge rays is carried out, a corona discharge line is constituted, after reducing that number of juxtaposition lines in some intermediate locations and carrying out to one at last, track termination may be opened wide, above-mentioned C decreases to whenever [that] at this time, and Zo goes up. Or while making a corona discharge line from a thin band-like conductor, making it make a counterelectrode generate corona discharge in arrangement and its sharp periphery section in parallel, and narrowing the width serially toward termination from an input edge, performing it, reducing the electrostatic capacity C to a counterelectrode and making width into zero termination, it is good also as an open end. Such a corona discharge pole will be called a peaking discharge electrode below. The above other pulse peaking can be performed also by compressing the width of a pulse and making it small by the suitable approach, (this being called pulse compression), and it is not necessary in the corona transmission line of this invention to say that pulse peaking may be carried out with the application of pulse compression.

Equipment can be miniaturized, so that the value of fp is made high, since the time amount which gas cleanups, such as denitrification and desulfurization, take is mostly in inverse proportion to the frequency fp of the ultrashort pulse high voltage to impress. It is good to select 50Hz or more of fp(s) to 250Hz or more preferably practically in operation of this invention.

As a high-pressure ultrashort pulse power source for generating the ultrashort pulse high voltage with short width in such a degree of pole Although what kind of suitable thing may be used, capacitive energy are recording elements which generally connected a capacitor, a coaxial cable, or two or more capacitors and inductances to the ladder mold as an energy are recording element (it is also called a pulse-shape shaping element), such as LC ladder mold circuit, are used. This is charged with the direct-current high voltage. Subsequently this A fixed spark gap, A rotary spark gap, Or it is suitable to use the thing (for a capacity are recording mold to be called) of the format which discharges through direct or a coupling capacitor and forms this ultrashort pulse high voltage between the two electrodes of the corona electrode system of this invention which is a load in an instant with high-speed switching devices, such as

hydrogen thyratron. However, an inductance is used as an energy are recording element, a direct current is beforehand passed in that coil, and the thing (an inductance are recording mold is called) of a format which impresses the pulse height electrical potential difference which appears that current in these inductance both ends in a high-speed switching device in an instant at disconnection and this time to the load of this invention through direct or a coupling capacitor may be used. When using a fixed spark gap with a capacity are recording mold high-pressure ultrashort pulse power source The electrical potential difference in the charge process of capacitive energy are recording elements, such as a capacitor Although the suicidal-explosion mold spark gap to which you make it boast of a spark gap may be used when the sparking voltage of a gap is exceeded, if the tripartite spark switch which has the other trigger electrodes of the main sparking electrode, for example is used A trigger electrode is made to be able to generate a spark by giving the pulse voltage for triggers at the necessary time, and a switch operation can be made to discover. Such an external trigger mold fixed spark switch can constitute the laser beam for triggers also from irradiating a sparking electrode at the necessary time again, and it makes a spark generate and it deals in it at the moment of the exposure. As a high-speed switching device, such an external trigger mold fixed spark switch, The above-mentioned capacitive energy are recording element is charged through a half wave rectifier not with the direct-current high voltage but with the alternating current high voltage using a rotation spark switch, hydrogen thyratron, etc. When making it make this high-speed switching device turn on only within the moment of taking near a null voltage value after this alternating current high voltage completes charge, or the half period which carries out **** reversal and which this half wave rectifier blocks While being able to prevent generating of the rush current from this instantaneous power source to a load, charge loss can be sharply decreased as an advantage of an alternating current charge proper, and the power efficiency of a high-pressure ultrashort pulse power source can be improved sharply.

Next, it faces impressing the ultrashort pulse high voltage of this invention to the usual corona electrode system which is not the corona transmission line, and it acts as a concentrated-constant load with which this corona electrode system consists of juxtaposition quantity resistance accompanying inter-electrode electrostatic capacity and corona loss, and with the inductance of the feeder circuit which connects a corona electrode system with a part for this capacity, the electrostatic capacity of a high-pressure ultrashort pulse power source, and that inductance, a switching device, and this power source, LC coupled vibration of a RF occurs and sparking voltage falls sharply.

Then, in order to prevent this coupled-vibration generating, to raise sparking voltage and to realize distance-average field strength higher than Epo of a formula (1) between gas gaps to stability The transmission lines, such as a long high-pressure coaxial cable with the geometrical length of a pulse voltage, an EQC, or the die length beyond it, are inserted between a pulse power source and a corona electrode system. It is good to separate the circuit-mutual intervention by the side of a power source and a load, as it is impressed by the corona electrode system at that termination, after once making the pulse voltage into the progressive wave and making this track top spread. Such the transmission line will be called the separation Mr. transmission line below. This transmission line for separation is an indispensable element, in order to prevent causing the above-mentioned coupled vibration and to make it an ultrashort pulse high-voltage wave join a load in a form as it is, when the corona electrode system used for this invention is a concentrated-constant load, and using this transmission line for separation also makes one description of this invention. In this case, CR-attenuated wave train which that charge electrical potential difference discharges through a switching device to the input surge impedance (it consists of a part for pure resistance) of this transmission line for separation when using the capacitor for pulse-shape shaping as a capacitive energy are recording element, and is then produced is a rate as a progressive wave. $V = 1/\sqrt{LC}$

It comes out and a transmission-line top is spread. Therefore, it is Ls>=VT, when the die length Ls of a track sets width of a pulse to T (ns) for attaining the separation purpose. (4)

It is necessary to carry out. If it supposes that a high-pressure coaxial cable is now used as this transmission line for separation and the value of the progressive wave propagation velocity V on it is carried out in V= 0.2m/ns, it may be necessary to be Ls>=200m at the time of Ls>=100m and T= 1000ns at the time of T= 500ns.

[Function]

The electron generated in connection with corona discharge when forming in inter-electrode [of a ******** corona electrode system] larger distance-average field strength than Epo of the formula (1) which makes the features of this invention is powerfully accelerated in 1 mean free path, and remarkable high kinetic energy is gained. It acts as Shigeo of the chemical active species, such as oxygen of OH radical which becomes the basis which triggers gas cleanup reactions, such as desulfurization and denitrification, O and O3, and an excitation state, and O2 ion, in large quantities after colliding with molecules, such as O2, H2O, etc. which are contained in gas. By the powerful oxidation, NO2 and SO2 can oxidize to SO3, mercury vapour oxidizes immediately to a solid oxide, and NO can be easily removed from gas in the water solution of a suitable absorbent. The great portion of NO2 is decomposed in a discharge chemistry-operation of the electron which has powerful energy. moreover, the time of adding hydrogen chloride gas etc. beforehand the case of the suitable additive for inside, for example, NO and SO2, in the case of ammonia gas and mercury vapour -- the above -- Since you make it able to combine with NH3 and inversion immobilization of inversion immobilization and the mercury vapour can be carried out to a solid ammonium-sulfate particle at the chlorine compound of the solid-state, SO2 becomes possible [removing pollutants, such as NOx, SO2, and mercury vapour, from gas completely]. That is, the fundamental mechanism of action of the gas cleanup effectiveness, such as very high denitrification, desulfurization, etc. of a proper, is in having made the rate and yield of the gas cleanup reaction in which this invention accelerates an electron to level absolutely impossible till now, makes the energy go up remarkably, and includes denitrification and desulphurization reaction over the conventional wall within 1 mean free path by this for the first time, or a discharge chemistry-reaction improve by leaps and bounds at this invention.

[Example]

Fig. 1 uses especially the gas cleanup equipment by this invention as exhaust gas denitrification and a desulfurizing plant, and drawing of longitudinal section of one example of a use **** thing and Fig. 2 show the cross-sectional view. 1 is casing which consists of the inlet port 2 of the gas containing NOx and SO2, the outlet 3 of the gas after a nitric acid and desulfurization, a hopper 4, and the grounded metal that has the dust exhaust port 5. The touch-down **** perpendicular parallel tabular counterelectrode group 6 and 6' are arranged in the interior at equal intervals, insulating arrangement is carried out in the middle of casing and this counterelectrode group, and the linear corona discharge electrode group 8 by which support firm bridging was carried out is in the rectangle-like metal housing group 7. This housing 7 is supported with the metal stanchion 12 which penetrates a porcelain tube 11 in the upper part with the supporting insulator which set caudad and was fixed on the level beam 9, and is insulated from the earth. Through the circuit changing switch 13, it connects with the straight polarity output terminal of the bias direct-current high voltage power supply 15 of output voltage Vb through the ** style inductance 14 further, and one of these the stanchions 12 is further connected to the forward output terminal of the ultrashort high-pressure pulse power source 18 through the coupling capacitor 16 and the high-pressure coaxial cable 17 in drawing of this example. The ultrashort pulse high voltage which this pulse power source 18 generates gives distance-

average field strength with the mesial magnitude width Tp of that pulse fully large [that peak value electrical potential difference ****] in 500 or less ns, and sufficiently larger above-mentioned bias voltage Vb and superposition **** full wave high price electrical potential difference (****+Vb) than Epo given by the formula (1), and makes the requirements for this invention fully satisfy. Moreover, in this example, this corona discharge electrode group 8, the counterelectrode group 6, and the corona electrode system that consists of 6' form the lumped constant circuit, therefore the duty of the already described transmission line for separation has also achieved this high-pressure coaxial cable 17. namely, the appearance with which the die length Ls of this coaxial cable 17 fills a formula (4) -- it has taken fully for a long time. If a circuit changing switch 13 is now thrown into the left, the bias direct-current high voltage power supply 15 will be separated, and it will be impressed between the direct corona discharge electrode group 7, the counterelectrode group 6, and 6', without the output voltage of the ultrashort high-pressure pulse power source 18 minding a coupling capacitor 16. 20 is an ammonia container and ammonia gas is blown into inlet-port dust 23 from a nozzle 22 through a feed pipe 21. The gas containing NOx and SO2 flows the corona discharge electrode group 7, the counterelectrode group 6, and the gas passageway 19 between 6' up after mixing the ammonia gas of the equivalent in the sum total **** thing and chemistry target of NOx and SO2 which were blown from penetration and a nozzle 22, and reaches an outlet 3, it is led to the suitable dust collector for sulfuration particle removal by the inlet port 2 from this, and an ammonium-sulfate particle is discharged from it to an after [removal ****] stack. By impression of the above-mentioned ultrashort pulse high voltage, the counterelectrode group 6 and the forward corona discharge of the shape of a powerful streamer which bridges a gas passageway 19 toward 6' occur, the most decomposes NOx into the bottom of existence of ammonia according to the powerful discharge chemistry operation at N2 and H2O, and after SO2 oxidizes and oxidizes to SO3, it combines with NH3 and serves as a solid particulate of an ammonium sulfate from the corona discharge electrode group 8. The part falls in the downward hopper 4, is deposited here, and is discharged outside from the dust exhaust port 5. The remaining detailed ammonium-sulfate particle is said-**(ed) by gas, reaches a gas outlet 3, and is led outside.

This high-pressure coaxial cable 17 serves as the duty of the transmission line for decomposition which is 150m in overall length and was already described, and the propagation velocity of the pulse voltage on it fulfills the conditions of the formula (4) as 0.2m /, 500ns of pulse width therefore, and the transmission line for separation ns. Consequently, to the pulse voltage of 500ns of width, although the corona electrode system in this example is a capacitive concentrated-constant load, it is impressed between the corona discharge electrode group 8, the counterelectrode group 6, and 6' by the wave with the ultrashort pulse high voltage almost as it is which has spread the cable top. Next, it is reflected and return and a following multiple echo are repeated for a cable 17 top to a pulse power source as the same polar pulse voltage. However, in case it is reflected from the corona electrode system with this steep ultrashort pulse high voltage which has a capacitive concentrated-constant load since a part contains a high high frequency component by starting, a capacitive component works as a short circuit mostly. Therefore, only this part is inverted and a reflective forward pulse wave becomes what contained the negative very short mustache-like pulse part only in that standup part. It prevents that a direct-current charge accumulates 24 in the core wire of a cable by the high resistance for charge leakage.

The water solution thru/or suspension water of water, and a NaOH-Na2CO3 and CaOH-CaCO3 grade is supplied as a lean solution from the upper part of a counterelectrode 6 and 6' instead of pouring in ammonia by this example, you make it flow down this on a field along the front face of 6 and 6', liquid membrane may be made, the generation oxide of NO2 and SO3 grade may be made to absorb on this, and the gas cleanup effectiveness very high at this time can be attained.

one line by which insulating firm bridging of Fig. 3 was carried out in the corona electrode system in the example of Figs. 1 and 2 on the perpendicular cylindrical counterelectrode 25 which served as touch-down casing, and its shaft -- it is drawing of longitudinal section of the small exhaust gas denitrification and the desulfurizing plant by this invention constituted only with the corona discharge pole 8. Further, omit the pulse power source 18, the ammonia container 20, this feed pipe 21, and the impregnation nozzle 22, and they are not drawn [in / the name and function of an element of a number to result in 17 from 2 in drawing are the same as it of the element of the same number in Fig. 1 and Fig. 2 , and / this Fig.]. NOx introduced from the gas inlet 2 after adding ammonia gas, and the gas containing SO2 complete denitrification and desulphurization reaction in the discharge chemistry operation with the streamer corona discharge of the shape of a forward pulse produced towards 25 to the utmost than the corona discharge pole 8, while going up the gas passageway 19 inside the cylindrical counterelectrode 25 which served as casing, and they are discharged outside from a gas outlet 3. Also in this case, it is not necessary to make the liquid membrane of the lean solution of NO2 and SO3 grade resultant on the wall of the cylindrical counterelectrode 25 instead of ammonia impregnation, and to say that this liquid membrane may be made to absorb these resultants.

the top-horizontal-discharge support by which Fig. 4 removed the housing 7 in the example of Fig. 1 and Fig. 2 , and insulating support was carried out in the linear corona discharge electrode group 8 in the upper part at the up supporting insulator 26 -- the bottom-horizontal-discharge support by which fixed to the conductor 27 and insulating support was carried out in the lower part at the lower supporting insulator 10 -- it is one example of this invention which carried out fixed firm bridging and which was constituted through the insulating material 29 in the conductor 28.

Although all elements other than [in / other names and functions of an element of a number in drawing are the same as it of the element of the same number of Figs. 1 and 2 and / Fig. 1 and Fig. 2] this (except for 7) exist also in this example, they are omitted, and they are not drawn. To Fig. 1 and Fig. 2 using the corona electrode system as a lumped parameter system, by this example, a standup is more steep, it only remains as it is, impression use is carried out [the shorter forward ultrashort pulse high voltage of width is put on the forward bias direct-current high voltage or], and the description is in the place using this ultrashort pulse high voltage as a progressive wave. namely, the wave front of the ultrashort pulse high voltage which invaded in casing 1 from the stanchion 12 through the circuit changing switch 13 -- top-horizontal-discharge support -- a conductor 27 -- minding -- all lines with a die length of about 6m -- it is distributed to the corona discharge electrode group 8, and goes on caudad in the direction of an arrow head 30. And the forward corona discharge of the shape of a powerful streamer is produced toward the counterelectrode group 6 and 6' in the meantime, and since energy is rapidly lost in that case and the wave height section suffers a loss, if it goes on about 3m, corona generating capacity will be lost. However, if it goes on 3 morem, it will result in the lower limit section of the open condition supported with the insulating material 29, and total reflection of this pulse height electrical potential difference is carried out to the same polarity, a penetration wave and a reflected wave lap, and peak value occurs twice [about] and produces peaking here. Collecting pulse generating capacity again as a result, a reflected wave produces the forward corona discharge of the shape of a powerful streamer for about about 3m, advancing toward the upper part. As a result, an angle corona discharge pole with an overall length of 6m will produce powerful forward corona discharge over the whole, and denitrification / desulfurization operation will be performed effectively.

Thus, since attenuation of the wave height section by forward corona discharge is remarkable when using a forward pulse height electrical potential difference as a progressive wave, it is indispensable to use peaking together by considering termination as disconnection. still lengthening the corona transmission line not much -- semantics -- there is nothing -- at most -- if an overall length is not pressed down to about 6-10m, the part which corona discharge does not generate in the pars intermedia of a corona discharge

line will produce it. therefore, in order to process a lot of gas, the number of juxtaposition electrodes of a corona electrode system is increased -- ****** -- a case -- casing 1 -- the upper part -- extending -- the corona electrode system of the same structure as this part -- top-horizontal-discharge support -- a reversal arrangement **** thing is arranged in the shape of symmetry as common in a conductor 27, and the need of lengthening the residence time is produced. Of course in this case, a porcelain tube 11 must be formed in the side attachment wall of casing 1. Moreover, since the die length of each corona discharge line 8 is 6m and there is little attenuation accompanying the corona discharge under propagation on the line of a negative pulse voltage far when output voltage of a bias direct-current high voltage power supply and output voltage of an ultrashort high-pressure pulse power source are made into negative polarity by this example, a corona electrode system works as a lumped constant circuit. Then, it is necessary to lengthen enough the high-tension cable 17 (not shown in drawing) to be used, and to consider as the transmission line for separation. While putting on the discharge electrode group 8 at the bias direct-current high voltage at this time, impressing the ultrashort pulse high voltage by the wave as it is and performing denitrification and desulfurization, the electric charge of the dust and the generation ammonium-sulfate particle which were contained in exhaust gas is carried out, and uptake of this is carried out on the counterelectrode group 6 and 6' in an electrostatic precipitation operation. moreover, if a switch 13 is thrown into the left, the negative ultrashort pulse high voltage will be impressed by the direct corona electrode system -- having -- the inter-electrode electrostatic capacity of not only generating negative corona discharge but this corona electrode system -- charging -- direct-current electric field -- formation -- an electrostatic precipitation operation is produced too. However, when an anion produces migration and an anion current from the corona discharge region near the corona discharge pole toward a counterelectrode in this case, since the charge stored in the above-mentioned inter-electrode electrostatic capacity discharges and the electrical potential difference of the corona discharge pole 8 shows CR attenuation, it will be in the indentation, and becomes that to which the steep ultrashort pulse electrical potential difference lapped with that crowning. Moreover, if a cable 17 is shortened or it omits, the voltage waveform of a corona discharge pole will become that with which the RF damping oscillation by the coupled vibration which is the wave front section and was already stated to the above-mentioned saw-tooth wave lapped.

The corona discharge pole 8 is laid in the middle of the touch-down counterelectrode group 6 which faces, and 6' in the shape of zigzag. one long line with which the overall length Lo is satisfied of the conditions of a formula (2) using the ultrashort pulse high voltage negative in Fig. 5 -- And it considered as the corona transmission line by having considered termination as disconnection, and by this example, this equipment serves as the electrostatic precipitator with drawing of longitudinal section of the exhaust gas denitrification and the desulfurizing plant by this invention of the method to which negative corona discharge is made to perform, making a pulse voltage spread as a progressive wave. The perpendicular counterelectrode group 6 and 6' by which touch-down arrangement was carried out into casing 1 in drawing serve as the dust collecting electrode. the line by which firm-bridging immobilization was carried out at the insulated metal housing 7 through the porcelain tube 3, the lower insulating material 29, and the up insulating material 32 -- the corona discharge electrode group 8 It connected in the corona 33 for peaking which served as lower connection lead wire by turns, and the corona 34 for peaking which served both as up connection lead wire, and while forming the corona transmission line 35 of long zigzag-like termination disconnection, it serves as the discharge electrode of an electrostatic precipitator.

And the corona transmission-line group 35 arranged by juxtaposition between each counterelectrode is connected to a circuit changing switch 13 in the upper part of the input edge 36 through the common lead wire 37 for distribution and the porcelain tube 38 which were connected with these. [many] In drawing of this example, while connecting with the negative output terminal of the bias direct-current high voltage power supply 15 through the ** style inductance 14, it connects with the negative output terminal of the high-pressure ultrashort pulse power source 18 which is not shown in drawing through the coupling capacitor 16 and the high-pressure coaxial cable 17. The regular negative direct-current bias high voltage is impressed to the corona electrical transmission track 35 by this. The negative ultrashort pulse high voltage advances into the interior of casing 1 as a progressive wave through a porcelain tube 38 at this in piles. After being distributed through a conductor 37, it is impressed by the input edge 36 of each corona transmission line 35. common -- The denitrification and de** of exhaust gas which include negative corona discharge for penetration **** NOx and SO2 in casing 1 from an inlet port 2 beforehand in generating and its discharge chemistry operation covering an overall length after adding ammonia are performed going on 35 tops in the shape of zigzag in the direction of an arrow head 39. Moreover, the dust to which the anion produced in negative corona discharge at this time floated in gas, and the electric charge of this is powerfully carried out to negative, therefore KURONKA separates from gas and uptake of the dust is carried out to the front face of the dust collecting electrode group 6 which served as the counterelectrode, and 6'. Under the present circumstances, SO2 oxidizes to SO3 and uptake also of the ammonium-sulfate particle which combined with NH3 further and was produced is similarly carried out to the front face of 6 and 6' by electrostatic precipitation operation. Therefore, this dust collecting electrode group 6 and the dust layer by which uptake was carried out by giving a mechanical shock to 6' with hammering equipment 40 fall caudad, and is accepted in a hopper 4. In this case, that particle size of an ammonium-sulfate particle is very fine, and it is deposited also on the corona discharge electrode group 8, since there is an inclination which controls corona discharge, with another hammering equipment 41, hammers the housing 7 of 8 and removes this. The clarification gas removed in NOx, SO2, and dust is led to a direct stack. The progressive wave pulse height electrical potential difference of negative polarity does not generate the corona discharge of the shape of a long streamer which bridges inter-electrode compared with it of straight polarity, but corona discharge is limited to the near field of a corona discharge pole. Therefore, a gas passageway has being filled [little] with positive/negative amphipathy ion with the operation to which it is filled by only the unipolar anion which flows toward a counterelectrode from a corona discharge field, and the whole gas gap discharges a particle charge like a forward streamer corona. As a result, by negative corona discharge, the electric charge by the anion bombardment to a dust particle of a gas passageway becomes almost possible in the whole region, and an electrostatic precipitation operation is discovered. That is, in order to carry out the denitrification and the desulfurizing plant by this invention and to serve as and close an electrostatic precipitator, it is indispensable conditions to use the negative ultrashort pulse high voltage. however -- since a negative corona is localized only to the near region of a corona discharge pole like **** -- (1) -- denitrification and desulfurization are performed only in the field, but since the use effectiveness of space is bad, a big tooth space and the long residence time are needed. (2) moreover, there is little energy expenditure per corona discharge pole unit length, and compared with a forward pulse, the deficit of the wave height section of the ultrashort pulse high voltage accompanying corona discharge boils only the part accompanying the localization of a corona markedly, and decreases. If it puts in another way, the effective length in whom corona discharge Narimasa on the corona transmission line is possible will become long. However, the property of (1) and (2) is convenient rather, when performing denitrification and desulfurization within the electrostatic precipitator of the large volume. It is the same as the case where the forward ultrashort pulse high voltage is used that it is necessary to open termination wide in this case, of course, and to perform peaking.

when a circuit changing switch 13 is thrown into the left by this example, the negative bias direct-current high voltage power supply 15 is separated, and the negative ultrashort pulse high voltage is common to distribution from the direct cable 17 -- it is impressed by

each corona transmission line 35 through a conductor 37, and a it top is spread as a progressive wave pulse height electrical potential difference. In this case, if peak value of a pulse height electrical potential difference is made sufficiently high, powerful negative corona discharge will be generated and denitrification / desulfurization operation will be demonstrated. Moreover, the damped oscillation of a pulse voltage with the electrical potential difference of the corona discharge pole 8 steep in the wave front section of the negative saw-tooth wave electrical potential difference by CR attenuation or high frequency becomes what lapped (when it shortened, or it takes and a cable 17 is removed) at the already explained reason, a direct-current electric-field component appears in an inter-electrode gas passageway, and electrostatic precipitation of dust and a generation ammonium-sulfate particle is performed. In this example, the direction of the inductance value of the peaking coil 34 above the inductance value of the lower peaking coil 33 serves as size, the surge impedance of the transmission line in an inserting point is raised one by one, and peaking of a pulse voltage is performed by this. As a result, the pulse height section is gradually lost by the corona discharge under propagation, and it can prevent that corona discharge becomes weaker. An option as shown below can also perform such peaking.
namely, Fig. 6 (a) -- the example of Fig. 5 -- setting -- the corona transmission line 35 -- two or more parallel connection **** -- a line -- the series connection of the group (it is called a stage below) of the corona discharge pole 8 is carried out further, he is formed, and peaking of a pulse voltage is performed by carrying out sequential reduction of the juxtaposition corona discharge pole, and going up the surge impedance of the transmission line. It consists of parallel connection of the corona discharge pole 8 having been carried out. this example -- the line of a first stage -- vertical [by which insulating support was carried out at the metal housing 7 at the insulating materials 32 and 29 of the fixed **** upper and lower sides] level [the corona discharge electrode county 42] support -- conductors 43 and 44 -- the line of three firm-bridging fixed **** -- level support of the upper and lower sides with 45 [step / 2nd / same] -- conductor 43' and 44' -- parallel connection **** of two firm-bridging **** -- a line -- corona discharge pole 8' -- It consists of 8" of corona discharge poles. the 3rd -- step 46 -- the upper and lower sides -- insulating materials 32 and 29 -- the line of one firm-bridging fixed **** -- Series connection of each stage of 42, 45, and 46 is carried out by connecting the upper limit of 8" of corona discharge poles with a conductor 44, 44', and 43'. respectively -- a lower limit and upper limit -- connection lead-wire 33' and 34' -- level support -- The corona transmission line 35 of termination disconnection where surge impedance goes up from the input edge 36 to a three-stage toward termination 47 is formed. Thereby, by corona discharge, peaking with the sufficient progressive wave pulse voltage which suffered a loss in the wave height section is performed, and homogeneity and flourishing negative corona discharge appear covering the overall length of this corona transmission line. The names and functions of an element of a number other than the above in this drawing are the same as it of the element of the same number of Fig. 1 , Fig. 2 , and Fig. 5 . However, the container 20 of ammonia, the impregnation pulse 21, the impregnation nozzle 22, the ** style inductance 14 connected with a circuit changing switch 13, the bias direct-current high voltage power supply 15, a coupling capacitor 16, the high-pressure coaxial cable 17, and the high-pressure ultrashort pulse power source 18 are omitted, and are not drawn on this Fig.
Fig. 6 (b) -- Fig. 6 (a) -- setting -- juxtaposition -- a line -- by turning caudad the width of corona discharge pole 8a and 8a' from the upper part, and reducing instead of reducing a corona discharge pole serially and performing peaking It is what reduced these counterelectrodes 6 and the electrostatic capacity to 6', turned surge impedance caudad, raised it continuously, and performed peaking, and the method of this example is suitable as an approach of performing the peaking simply especially at the time of impression of the forward ultrashort pulse high voltage. Such corona discharge pole 8a and 8a' are called peaking-discharge electrode. The names and functions of an element of a number other than 8a in drawing and 8a' are the same as it of the element of the same number of Fig. 6 (a), and further, in drawing, the ** style inductance 14, the forward bias direct-current high voltage power supply 15, the forward high-pressure ultrashort pulse power source 18, and the high-pressure coaxial cable 17 are omitted, and they are not drawn.
Fig. 7 is equipment which constitutes a 3 electrode type corona electrode system from drawing of longitudinal section of one example with the corona discharge pole 8, the third electrode 47 of a non-corona and the counterelectrode 6 of the pair of these both sides, and 6' now [of this invention], and constitutes this as the long corona transmission line 35, and was made to perform denitrification, desulfurization, and dust collection of exhaust gas. drawing -- setting -- middle -- a standard -- 48 -- ' -- having -- un--- a corona -- the -- three -- an electrode -- 47 -- having served -- a metal -- a housing -- seven -- ****** -- perpendicular -- a metal -- **** -- 48 -- 48 -- ' -- 48 -- " -- middle -- This and parallel insulate from this and the corona discharge pole 8 and 8' are arranged in them. a line -- Firm-bridging immobilization is carried out with the up insulating material 32 fixed to the porcelain tubes 31, 49, 50, and 27 which penetrate conductors 27 and 28. level support of the upper and lower sides of a housing 7 -- A corona discharge pole is formed. and series connection is carried out by connection lead-wire 33' -- having -- the line of long termination disconnection of one -- The four partial corona transmission lines are formed between third electrode of non-corona 48-48' of the pair of each both sides, 48'-48" and the counterelectrode 6 of a pair, and 6', and these form the one corona transmission line 35 by which parallel connection was carried out. The metal housing 7 is connected to the negative output terminal of the bias direct-current high voltage power supply 15 through a stanchion 12, lead wire 58, the switch 51, and the ** style inductance 14, and the negative bias direct-current high voltage is impressed also to the corona discharge pole 8 through the 2 ream circuit changing switch 52, lead wire 53, and the high resistance 54 for leakage. The core wire 56 of the high-pressure coaxial cable 17 with which the envelope 55 was insulated, an envelope 55 and lead wire 53, the circuit changing switch 52 of 2 ream, and lead wire 57 and 58 are minded. the conductor from the high-pressure ultrashort pulse power source 18 insulated now -- It is impressed with the polarity which makes the former negative through a conductor 37 and the metal stanchion 12 between the input edge 36 of the long corona discharge pole 8, and the upper left edge 59 of the metal housing 7. the supplied ultrashort pulse high voltage is common to distribution -- Subsequently, the juxtaposition corona transmission line which consists of 8-48, 8-48', 8-6, and 8-6', Subsequently, the juxtaposition corona transmission line of the termination disconnection which consists of 8'-48', 8'-48", 8'-6, and 8'-6' is spread as a progressive wave pulse height electrical potential difference. Mainly it goes between them than 8, goes to 48' and 48" from 48, 48', and 8', powerful negative corona discharge is performed, and desulfurization and denitrification of exhaust gas are performed. Moreover, the anion produced at this time is driven to a counterelectrode 6 and 6' in an operation of the direct-current electric field currently formed in the gas passageway in the operation of the bias direct-current high voltage power supply 15, the dust and the generation ammonium-sulfate particle in exhaust gas in the meantime, carries out the electric charge of this to negative, and it carries out separation uptake on the counterelectrode 6 which served as the dust collecting electrode in the operation of KURONKA, and 6'. Since the 3rd electrode 47 of a non-corona is used, the description of this method can select sufficiently small the distance of this, and the corona discharge pole 8 and 8', and even if it makes comparatively low the value of the output pulse electrical potential difference of a high pressure ultrashort pulse power source, it is that it can form easily the high electric field which satisfy the electric field value conditions for denitrification and desulfurization of this invention between two electrodes. Of course, if it progresses even if a part of negative corona goes to a counterelectrode 6 and 6' in [' / the corona discharge pole 8 and / 8] this case, and output voltage of the bias direct-current high voltage power supply 15 is made sufficiently high, denitrification and desulphurization reaction will be performed also in the gas passageway 19 between the corona discharge pole 8, 8', and a counterelectrode 6 and 6'. In addition, if the 2 ream circuit changing switch 52 is thrown into the right, switched on [51], since the ultrashort pulse high voltage supplied through a cable 17 from the high-pressure ultrashort pulse power source 18 will be

impressed to lead wire 57 and 58 through coupling-capacitor 60' and 60, the need for an insulation of this high-pressure ultrashort pulse power source 18 is lost, and it can also ground the envelope 55 of the high-pressure coaxial cable 17. Although the bias direct-current high voltage stops building over the corona discharge pole 8, and 8' and the third electrode of a non-corona and denitrification / desulfurization operation is continued if a switch 51 is turned off, an electrostatic precipitation operation disappears.
Carry out fixed firm bridging and it uses for conductors 27 and 28. Fig. 8 -- drawing of longitudinal section of one example of the now of this invention -- it is -- the 7th drawing 7 Fig. -- setting -- instead of [of the third electrode 47 of a non-corona] -- a line -- level support of the upper and lower sides of the corona discharge pole 61, 61', and the third electrode 62 of a corona that consists of 61" -- 61-61', the corona discharge pole 8 of a line [middle / 61'-61"], and 8' -- the upper part -- setting -- top-horizontal-discharge support -- the porcelain tube 31 which penetrates a conductor 27, and 31' -- caudad -- setting -- bottom-horizontal-discharge support -- it lays by the insulating material 29 and 29' which were fixed to the conductor 28, and insulating arrangement is carried out. the upper limit of 8 and 8' is common to distribution -- it connects with a conductor 37 and connects with a porcelain tube 38, lead wire 57, and the core wire 56 of the high-pressure coaxial cable 17 connected to the forward output terminal of the high-pressure ultrashort pulse power source 18 insulated through the 2 ream circuit changing switch 52. moreover, top-horizontal-discharge support -- a conductor 27 is connected with the forward output terminal of the bias direct-current high voltage power supply 15 through the metal stanchion 12, lead wire 58, a switch 51, and the ** style inductance 14 in the right end -- having -- further -- the conductor with which the above-mentioned high-pressure coaxial cable 17 was insulated through the 2 ream circuit changing switch 52 -- it connects with the envelope 55. The high resistance 54 is always 8minded [the corona discharge pole 8 and]. therefore, a line -- The forward bias direct-current high voltage is impressed to the touch-down counterelectrode 6 and 6' like the third electrode 61 of a corona, 61', and 61". a line -- The ultrashort pulse high voltage is impressed to this at the corona discharge pole 8 and 8' with the **** polarity which makes 8 and 8' straight polarity to 61, 61', and 61" in piles. In this case, it goes to 8 from 61 and 61' first in the process which the wave front section with the steep ultrashort pulse high voltage spreads toward the bottom from a top. Moreover, negative streamer-like corona discharge arises toward 61" to 61' and 8'. Are induced by this, and toward 8 to 61, 61' and 6, and 6', powerful forward streamer-like corona discharge arises toward 61' [from 8'], 61" and 6, and 6', and between both corona discharge poles and the corona discharge pole 8, 8' and a counterelectrode 6, and the gas passageway 19 between 6' are bridged. Denitrification and desulfurization of exhaust gas are performed. In this case, since the die length of 8 and 8' serves as an open end in which it is about 6m and a peaking operation has a lower limit, uniform positive/negative corona discharge is produced covering the overall length of about 6m in spite of the remarkable deficit of the ultrashort pulse high-voltage wave height section accompanying forward corona discharge in the already explained reason. The advantage when also making the third electrode into a corona discharge pole like this example (1) Discharge chemistry-denitrification / desulfurization operation by the third electrode 61, 61', and the outrider negative corona discharge from 61" is added, (2) An electron is beforehand generated by both corona inter-electrode and the gas passageway 19 according to the ionization by collision and photoionization operation by this streamer-like outrider negative corona discharge. The negative corona streamer which moreover extended to the corona discharge pole 8 and near 8' Since powerful electronic space charge electric field are produced in the front face of 8 and 8', the next moment, from 8 and 8', extremely, it becomes powerful and the streamer corona discharge of right ****** is in stability and the point that denitrification / desulfurization operation is demonstrated more effectively. It is the same as that of the example of Fig. 7 that it will become unnecessary to insulate the high-pressure ultrashort pulse power source 18 if the 2 ream circuit changing switch 52 is moved to the right. Moreover, since the forward bias direct-current high voltage will no longer be impressed to 8, 8', 61, 61', and 61" if a switch 51 is turned off, direct-current bias electric field are lost to a gas passageway. Although progress of the forward streamer corona discharge from 8 at the time of ultrashort pulse high-voltage impression and 8' to 6 and 6' becomes weaker and the denitrification / desulfurization effectiveness decreases, the dust collection effectiveness appears.
Fig. 9 is an example of an operation **** thing about this invention with the corona electrode system of 2 electrode types which made the counterelectrode itself the corona discharge pole. It is thrust into the spiral sulcus of the supporting insulators 66 and 67 which have the double helix slot which 63 and 64 are the double helix electrodes of the place which consists of two strands which have a rectangle cross section, respectively, and was fixed to the head lining 65 of casing 1 in the vertical edge, respectively, and the supporting insulators 68 and 69 which have the double helix slot fixed to the level beam 9 in drawing, and insulating firm bridging is carried out. And two strands, 63 and 64, 70-71 and 72-73 are mutually connected by the connection lead wire 74 and 75 in the lower limit, thereby, series connection of 63 and 64 is carried out, and they form the corona transmission line of one termination disconnection. and the input edge 79 -- lead wire 76 and 77 and a porcelain tube 7 -- minding -- the core wire 56 of the high-pressure coaxial cable 17, and the grounded conductor -- it connects with an envelope 55 and this connects with the high-pressure ultrashort pulse power source 18. The ultrashort pulse high voltage now impressed to the above-mentioned input edge 79 is caudad spread along with two strands 70 and 71 of the double helix electrode 63 as a progressive wave, and it moves to the lower limit of the double helix electrode 64 through 74 and 75 subsequently, spreads up along with the strands 72 and 73, and results in the disconnection termination 80, total reflection is carried out here, and peaking is performed. Along with the whole strands 72 and 73 of the strands 70, 71, and 64 of 63, powerful negative streamer-like corona discharge and the powerful forward streamer-like corona discharge which bridges between both strands are generated toward a partner strand from both strands in this tubing, and the denitrification and desulfurization of exhaust gas which were introduced from the upper inlet port 2 of addition of ammonia gas are performed. The purified gas is discharged after removing ammonium-sulfate dust through a dust collector to a stack from an outlet 3. 40 and 40' is hammering equipment attached for head lining 6, by the hammering impact, makes the downward hopper 4 fall and discharges outside the ammonium-sulfate dust which carries out adhesion deposition on the strand of a double helix electrode from an exhaust port 5. the description of this example -- both components -- a line -- corona discharge -- a pole -- it is having used the double helix electrode and the advantage on the structure where the already described common-like synergism of a ****** corona and a forward corona raises the denitrification / desulfurization effectiveness, and the space duty cycle of an electrode can be improved further, and the electrode of an a large number book can be attached easily is large.
Fig. 10 (a) shows one circuit system of the high-pressure pulse power source for generating the pulse height electrical potential difference with very short width used for this invention. In drawing, it connects with the upstream of a step-up transformer 82 by the low voltage main power supply, 81 supplies alternation principal voltage, the with a peak value [of 150kV] alternating current high voltage is generated in secondary [the], and this charges the tank capacitor 86 at negative 150kV through a half wave rectifier 83, protective resistance 84, and the ** style inductance 85. In this case, since the tank capacitor 86 is charged from null voltage to peak voltage with alternating voltage, the loss of circuit accompanying charge stops at a very small value peculiar to alternating current charge. Within the period of this charge half period, the rotation sparking electrodes 91, 92, 93, and 94 fixed to the rotator 90 insulated from the earth of the rotation spark switch 89 by which it is placed between the fixed sparking electrodes 87 and 88 connected to the end of this tank capacitor 86 and the end of the high-pressure coaxial cable 17 with the include angle of 90 degrees are all keeping away from 87 and 88 with sufficient separation, and a spark does not occur into this part. Namely, the rotator 90 insulated from the earth which this rotation spark switch 89 has the include angle of 90 degrees, is arranged, and has the sparking electrodes 91-94 of four

flow **** mutually, With the motor which the frequency of the above-mentioned secondary alternating current high voltage synchronizes, and is made to rotate this The rotation sparking electrodes 91-94 are being isolated from the fixed sparking electrodes 87 and 88 at the half period which has a rectifier 83 in switch-on exactly. Next, the polarity of the next half cycle of alternation principal voltage, therefore the secondary alternation electrical potential difference of a step-up transformer 82 is reversed. To the appearance which two pairs of rotation sparking electrodes 91-93 and any one pair of 92-94 approach [appearance] the fixed sparking electrodes 87 and 88 one by one within the period of the half period when the rectifier 83 changed into the inhibition condition, and generates a spark, in an operation of a phase adjuster 95 The phase of supply voltage, Therefore, it consists of the synchronous motor 96 by which the rotation phase was controlled. When the rotation spark switch 89 turns on by the spark now, the charge electrical potential difference of the tank capacitor 86 is the surge impedance Z of a coaxial cable 17. Discharge and its CR discharge wave spread to the method of the right as progressive waves of the negative ultrashort pulse high voltage through (the pure resistance R). It enters through a coupling capacitor 16 in the exhaust gas denitrification and the desulfurizing plant 97 by this invention. the long line of the shape of zigzag of the place to which the negative bias direct-current high voltage is beforehand impressed through the ** style inductance 14 by the negative direct-current bias high voltage power supply 15 -- it is impressed by the corona transmission line 35 which consists of a corona discharge pole, and denitrification and desulfurization / dust collection operation is performed.
It is the example of Fig. 10 (a), and Fig. 10 (b) shows the circuit system of the example of the ultrashort pulse high voltage power supply which should be used for this invention which the low voltage alternating current main power supply 81 consisted of the series connection circuit of the thyristor 99,100 of commercial-frequency AC power supply 98 and antiparallel connection, and used the full wave rectifier 101 instead of the half wave rectifier 83, and all other elements of it are the same as that of Fig. 10 (a) except for the control signal section 102 of a thyristor 99,100. Synchronizing with alternating current principal voltage, you supply a control signal to a thyristor 99,100 from the control signal section 102 by turns at the suitable phase time for every half wave of the, and make it flow through this in this example. When another control signal is further sent to a phase adjuster 95 through lead wire 103, this controls the rotation phase of a synchronous motor 96 and a thyristor 99,100 is in an ON state, the fixed sparking electrodes 87 and 88 and the rotation sparking electrodes 91-94 of the rotation spark switch 89 are being isolated enough, and do not generate a spark, but only when a thyristor 99,100 is an OFF state, the above-mentioned sparking electrode approaches and he is trying to generate a spark from the control signal section 102.
Fig. 11 shows the corona transmission line 35 of Fig. 10 (a) and (b), and the wave of a counterelectrode 6 and the electrical potential difference V produced between 6', and t shows time amount. A voltage waveform becomes the negative bias direct-current high voltage Vd with what the negative ultrashort pulse high voltage superimposed periodically. Therefore (Vd+****), it becomes the peak value (peak) value of the electrical potential difference which joins the gas passageway between two electrodes, and only the part of Vd can reduce the output voltage of a pulse power source, and it becomes economical. In this case, since the anion generated with the negative ultrashort pulse high voltage is driven to a counterelectrode 6 and 6' with the negative bias direct-current high voltage, it carries out the electric charge of the dust in exhaust gas, or the produced ammonium-sulfate dust by desulfurization by bombardment of an anion. And since direct-current electric field exist in a gas passageway with the above-mentioned bias direct-current high voltage, a drive and electrostatic precipitation operation of carrying out uptake appear in a counterelectrode 6 and 6' the particle by which it was electrified [this]. However, if it always impresses the bias direct-current high voltage to the corona discharge pole in using the forward ultrashort pulse high voltage especially (the equipment volume is sharply reducible in this case) when not aiming at dust collection but aiming only at denitrification and desulfurization of exhaust gas, since ion will move by direct-current electric field, the ion current will flow and remarkable energy loss will be produced in connection with this, it is not sometimes desirable. In this case, if a bias pulse height electrical potential difference with the easy width of formation instead of direct current voltage large as a bias high voltage is used, the power loss by the ion current can be reduced sharply, and it is convenient.
Fig. 12 is an example of the high-pressure ultrashort pulse power source which used together such a bias pulse height electrical potential difference for using for this invention. 104 with a high-pressure ultrashort pulse power source The low voltage main power supply 81, a step-up transformer 82, The full-wave-rectification machine 101, the attenuation resistance 84, the ** style inductance 85, the capacitor 105 for pulse-shape shaping that served both as the coupling capacitor, leakage resistance 106, and the fixed sparking electrode 107 and four rotation sparking electrodes 91, 92, 93, and 94 attached for the grounded rotator 89 top, The synchronous electric machine 96 for a drive, its phase adjuster 95, and its control signal section 108 consist of connection and the arranged thing like illustration. Moreover, 109 is a high-pressure bias pulse power source for generating a bias pulse height electrical potential difference. The low voltage commercial frequency power source 110, a step-up transformer 111, the full-wave-rectification machine 112, the attenuation resistance 113, the ** style inductance 114, the tank capacitor 115, the thyristor switching device 116, the rectifier 118 connected to this and reverse juxtaposition, the control signal section 108 of a switching device 116, The protective resistance 121 of the inductance 117 for resonance, a rectifier 118 and the serial small protection inductance 119, the thyristor switch 120 for residual-voltage reset, and its control signal section 108,120, circuit changing switches 122 and 123, the pulsing transformer 124 for pressure ups, The small protection inductance 125, the high-pressure lead wire 126,127,128 and the touch-down lead wire 129, and an output terminal 130,131 consist of connection and the arranged thing like illustration. the input edge of the cable 17 with which the output terminal 132,133 of the high-pressure ultrashort pulse power source 104 served as the transmission line for separation -- it is -- the core wire 56 and conductor -- it connects with an envelope 55 -- having -- the outgoing end of a cable 17 -- core wire 56 -- the corona discharge electrode group 8 of denitrification and a desulfurizing plant 97 -- moreover, a conductor -- the envelope 55 is connected to the counterelectrode group 6 and 6' which were grounded. Moreover, the output terminal 130,131 of the source 109 of bias pulse height piezo-electricity is connected to the output terminal 132,133 of the high-pressure ultrashort pulse power source 104, respectively, as shown in drawing. When the circuit changing switch 122,123 is now thrown in like illustration, the pulsing transformer 124 is separated. When the output voltage of the point ****** main power supply 81 takes the value near a zero value, the signal is told to the control signal section 108 through lead wire 134, the control signal for triggers is given to the control grid of a thyristor 116 through lead wire 135 from here, and 116 turns on. By this The forward direct-current high voltage of the tank capacitor 115 which has the electrostatic capacity Co big enough minds the inductance 117 for resonance of the inductance value L, lead wire 126 and 127, the protection inductance 125, an output terminal 130,132 and lead wire 129, and output terminals 131 and 133. Furthermore, it is impressed through a cable 17 between the corona discharge electrode group 8 of denitrification and a desulfurizing plant 97, the counterelectrode group 6, and 6'. Resonance charge of the inter-electrode electrostatic capacity Cl is carried out by the transient vibration of L and Cl of 117 to twice [about / about] as many electrical-potential-difference (peak value) +Vpo as the charge electrical potential difference Vo of a capacitor 115. However, it has considered as Co>>Cl. Next, similarly the electrical potential difference Vpo of Cl discharges toward Co of the tank capacitor 115 through the resonance inductance 117, a rectifier 118, and the protection inductance 119 by the transient vibration of L and Cl, and the forward bias pulse height electrical potential difference of the corona discharge electrode group 8, the counterelectrode group 6, and the peak value Vpo with the large width to which that width becomes settled in L and Cl between 6' is impressed in process of this round term. However, since this accumulates and the transient

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vibration by L and Cl itself stops occurring when the direct-current smallness electrical potential difference Vr always remains between terminals 130,131 for the loss of circuit and this is left, a trigger signal is given from 108 to the thyristor switch 120 for reset through lead wire 136 in the end of a round term, this is turned on, and residual voltage discharges through the small protective resistance 121 and this thyristor 120. In this case, although this residual voltage Vr will discharge through the secondary winding of a pulsing transformer 124 while this thyristor switch 120 for reset is separated, a pulsing transformer 124 is connected and the pressure up of the above-mentioned bias pulse height electrical potential difference is performed if a circuit changing switch 122,123 is thrown into an opposite direction, respectively, loss of a pulsing transformer is added. Now, when the above-mentioned bias pulse height electrical potential difference reaches the peak value Vpo, The slip ring 137 of the control **** rotating type spark switch 89 is minded for the rotation phase with the phase adjuster 95 controlled by the signal from 108. Any of the rotation sparking electrodes 91-94 arranged with the angle of rotation of 90 on a conductor 90 they are approaches the fixed sparking electrode 107, and a spark is produced. the grounded rotator -- The charge electrical potential difference of the capacitor 105 for pulse-shape shaping of the electrostatic capacity C which served as the coupling capacitor It discharges through the surge impedance Zo (=R) of this rotation spark switch 89 and the high-pressure coaxial cable 17 which served both as the transmission line for separation. The forward ultrashort pulse high voltage of the very short peak value Vpo of the width produced in CR discharge in that case spreads a cable 17 top on the right as a progressive wave. Superimpose, as an inhibition operation of the inductance 125 which does not let this steep pulse pass shows to Fig. 13 at the peak value Vpo of the above-mentioned bias pulse height electrical potential difference, and it is impressed between the corona discharge electrode group 8, the counterelectrode group 6, and 6'. The distance-average field strength in said superimposed electrical potential difference (Vpo+****) is formed in a gas gap, and effective denitrification / desulfurization operation is attained with remarkable high power efficiency.

Fig. 14 (a) shows one circuit system now [of the high-pressure ultrashort pulse power source for generating the ultrashort pulse high voltage for using for this invention]. The name and function of the element which results in 106 from 6 in drawing are the same as it of the element of the same number in Fig. 10 (a) and (b). however -- as the capacitive energy storage element for pulse shaping at this example -- instead of [of a capacitor 86] -- high-pressure coaxial cable 17 self -- using it -- cost reduction -- measuring -- **** -- the input edge 138 -- core wire 16 and a conductor -- the electrostatic capacity between envelopes 15 is charged through the small resistance 139 for attenuation, and the ** style inductance 140,141 from the tank capacitor 86 charged by the forward high voltage. Next, the **** spark switch 89 is connected to the core-wire side outgoing end 142 of this high-pressure coaxial cable 17 through lead wire 143. If this turns on, the charge electrical potential difference of a coaxial cable 17 minds a coupling capacitor 16 as a forward progressive wave pulse height electrical potential difference of the short paddle square wave of width. By the forward bias direct-current high voltage power supply 15 It superimposes on the forward bias direct-current high voltage given, and is impressed between the corona discharge electrode group 8 of denitrification and a desulfurizing plant 97, the counterelectrode group 6, and 6', and denitrification desulphurization reaction is performed. If a circuit changing switch 13 is thrown into the left, whenever the charge electrical potential difference of 17 which starts with the time constant in which the fixed sparking electrode 144,145 constitutes the fixed spark switch 147 of a suicidal-explosion mold, and becomes settled in the electrostatic capacity of resistance 139 and a coaxial cable 17 will surpass the sparking voltage of this spark switch 147, a spark occurs here, the ultrashort pulse high voltage is supplied to inter-electrode [of 97], and denitrification desulphurization reaction is performed. It is reflected, it is reflected, without advancing into the interior of a power source more than it in an inhibition operation of the ** style inductance 140,141, although it returns to hard flow, and it is decreased, this ultrashort pulse high voltage repeating a multiple echo below.

Although the high-pressure coaxial cable 17 is used as a capacitive energy are recording element in this example instead, LC ladder mold energy are recording element 17a which connects inductance 140a and 140a'-- with 86a and 86a'-- at a ladder mold, and changes as shown in Fig. 14 (b) can also be used.

Fig. 15 shows one circuit system now [of the high-pressure ultrashort pulse power source which should be used for this invention], and uses the suicidal-explosion mold fixed spark switch 147 which consists of a fixed sparking electrode 107 and a grounding working fixed sparking electrode 146 instead of the touch-down rotation spark switch in Fig. 12. The forward direct-current high voltage power supply 148 and output voltage of output voltage Vo - The capacitor 105 for pulse-shape shaping which served as the coupling capacitor through the attenuation resistance 84 and the ** style inductances 140 and 14 by the negative bias direct-current high voltage power supply 15 of Vb is charged by the electrical potential difference of Vo+Vb with the polarity of illustration. As opposed to the corona transmission line 35 of the denitrification and the desulfurizing plant 97 to which a spark will occur between sparking electrodes 107,146 in suicidal explosion if the charge electrical potential difference surpasses the spark generated voltage of the spark switch 147, the potential of one terminal 149 of this capacitor 105 turns into ground potential in an instant, the other-end child 150 becomes - (Vo+Vb), and the bias direct-current high voltage of -Vb is already given - The electrical potential difference of Vo is added. It charges again with the time constant in which the following moment capacitor 105 becomes settled in the electrostatic capacity of 105, and resistance of 84 according to power sources 148 and 15, and is restored to the original condition, the spark switch 147 turns on again, and this actuation continues below. In this process - Vo carries out CR attenuation with the above-mentioned time constant, and that CR attenuation voltage waveform serves as a necessary ultrashort pulse high voltage. In this case, both spacing changes with consumption of a sparking electrode 107,146, it originates in this and the sparking voltage of the spark switch 147 rises, since a rise and its frequency fall of a pulse voltage are produced, this is inputted into the sparking-voltage control unit 153 after that a potentiometer 151,152 detects sparking voltage, the control drive of the control unit 154 which grasped the sparking electrode 146 is carried out in the upper part so that sparking voltage may become fixed, spark spacing is controlled, and sparking voltage is kept constant.

In order to use the gas cleanup equipment by this invention for an actual emission-gas-purification process, there are various use gestalten. (a) - (e) of Fig. 16 shows some of the examples. Gas cleanup equipment **** according [the part 155 which gave the slash] to this invention. This drawing (a) installs this equipment 155 which used the forward pulse height electrical potential difference in the middle of an exhaust gas duct, and forms the agent feeding equipment 157 which consists of the container 20 of ** which pours in suitable additives, such as inside of the exhaust gas of the upstream duct 156, for example, ammonia etc., a filling pipe 21, and the impregnation nozzle 22. This drawing (b) the gas cooling tower 158 for cooling exhaust gas to the upstream and making gas cleanup effectiveness, such as denitrification desulfurization, temperature improve further in the bottom moreover, the downstream -- an ammonium sulfate -- the bag filter for carrying out uptake of the generation particle of a column -- It is what formed the suitable after-treatment equipments 159, such as a scrubber for absorbents, such as water, a NaOH water solution, and Na2CO3 water solution or milk of lime, to remove the water-soluble gas resultant of a scrubber thru/or NO2, and SO2 grade, and 160 is a stack. This drawing (c) is what prepared gas cleanup equipment 155,155' by this invention in the inlet-port duct 156, completes gas cleanup reactions, such as denitrification desulfurization, in the short residence time using the forward ultrashort pulse high voltage, respectively to 155,155', and carries out electrostatic precipitation of the generation particles, such as an ammonium sulfate, to the upstream settling chamber 161 of the electrostatic precipitator 164 which consists of three settling chambers 161,162,163 by settling chambers 162 and 163 with the dust

in exhaust gas. This drawing (d) uses the negative ultrashort pulse high voltage for the negative direct-current bias high voltage in piles in drawing (c) at all the settling chambers 161-163, and is a ********** thing about the gas cleanup by this invention, and the dust collection by the negative pulse electric charge of the electrostatic precipitator itself. This drawing (e) attaches the gas cleanup equipment 155 by this invention after the suitable pre-treatment equipments 165, such as an exhaust gas desulfurizing plant by the conventional wet scrubber method, a bag filter, and an electrostatic precipitator.
in addition, this invention -- for example, the interior of the cylindrical bag filter for dust collection -- a line -- the ******** type bag filter which prepared the corona discharge pole -- setting -- this -- a line -- it is not necessary to say that the ultrashort pulse high voltage may be carried out to the corona discharge pole by [direct] being, carrying out and being impressed by the bias direct-current high voltage in piles through a coupling capacitor, either
[Effect of the Invention]
This invention performs denitrification and desulfurization of exhaust gas that it is simultaneous and effectively by dry type completely according to a discharge chemistry operation of the corona discharge by the ultrashort pulse high voltage, without installation costs, such as a catalyst, a scrubber, and an electron beam, and running cost using the troublesome high equipment of maintenance. Therefore, there is also no corrosion of equipment, maintenance is also easy and an installation cost and running cost are cheap. Moreover, since denitrification and not only desulfurization but use of negative corona discharge can also perform electrostatic precipitation of the dust in exhaust gas within the same equipment, it is suitable.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
Drawing of longitudinal section of one example of the exhaust gas denitrification and a desulfurizing plant according [Fig. 1] to this invention and Fig. 2 are the cross-sectional view. Fig. 3 , the 4th drawing 4 Fig., Fig. 5 , Fig. 6 (a), Fig. 6 (b), Figs. 7 , 8 , and 9 , and drawing of longitudinal section of an example where ********** this inventions differed are shown. Fig. 10 (a) and Fig. 10 (b) show the circuit system with which the high-pressure ultrashort pulse power sources used for this invention, respectively differed, and Fig. 11 shows the voltage waveform obtained with these power sources. Fig. 12 shows one circuit system now [of the high-pressure ultrashort pulse power source used for this invention], and Fig. 13 shows the voltage waveform obtained by this. Figs. (a) 14 and 15 show the circuit system with which another high-pressure ultrashort pulse power sources used for this invention differed, respectively. Fig. 14 (b) shows the circuit diagram of LC ladder mold energy are recording element. Fig. 16 (a), Fig. 16 (b), and Figs. (c) (d) 16, 16, and 16 (e) show installation / use gestalt from which it differed in the case of using it, installing the gas cleanup equipment by this invention in the network of a process, respectively.
It is as follows when the name of the main elements in drawing is described.
1 .... Casing
2 .... Gas inlet
3 .... Gas outlet
4 .... Hopper
5 .... Dust exhaust port
6 6' .... A counterelectrode thru/or dust collecting electrode
8 8' .... Corona discharge pole
8a, 8a' .... Peaking discharge electrode
13 51,122,123 .... Circuit changing switch
15 .... Bias direct-current high voltage power supply
16, 60, 60', 105 .... Coupling capacitor
17 .... Cable
17 a....LC ladder mold energy are recording element
18 .... High-pressure ultrashort pulse power source
19 .... Gas passageway
22 .... Ammonia insufflation opening
23,156 .... Inlet-port duct
33 34 .... Peaking coil
35 .... Corona transmission line
40 41 .... Hammering equipment
48, 48', and 48" .... perpendicular -- a conductor -- **** 3 electrode
52 .... 2 ream circuit changing switch
61, 61', and 61" .... a line -- the third electrode as a corona discharge pole
81,110 .... Low voltage alternating current main power supply
82,111 .... Step-up transformer
83,118 .... Half wave rectifier
85 .... ** style inductance
86, 86a, 86a', 115,140,141 .... Tank capacitor
89 .... Rotation spark switch
95 .... Phase adjuster
96 .... Synchronous electric machine
99,100,116,120 .... Thyristor
101,112 .... Full-wave-rectification machine
102 .... Control signal section
117 .... Resonance inductance
124 .... Pulsing transformer
140,141,140a, 140a' .... Inductance
147 .... Suicidal-explosion mold fixed spark switch
148 .... High voltage direct current power source
151,152 .... Partial pressure resistance
153 .... Sparking-voltage control section
154 .... Control unit
155,155' .... Gas cleanup equipment
157 .... Agent feeding equipment
158 .... Gas cooling tower
159 .... After-treatment equipment
160 .... Stack
161,162,163 .... Settling chamber

164 .... Electrostatic precipitator
165 .... Pre-treatment equipment

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 特　許　公　報（Ｂ２）　(11)特許番号
第2649340号

(45)発行日　平成９年(1997)９月３日　(24)登録日　平成９年(1997)５月16日

(51)Int.Cl.⁶	識別記号	庁内整理番号	ＦＩ	技術表示箇所
ＢＯ１Ｄ　53/50			ＢＯ１Ｄ　53/34	１２２Ｚ
53/32			53/32	
53/34	ＺＡＢ		53/34	１２９Ｃ
53/56				ＺＡＢ
53/74				

発明の数１（全 21 頁）

(21)出願番号　特願昭61－134475
(22)出願日　昭和61年(1986)６月10日
(65)公開番号　特開昭62－289249
(43)公開日　昭和62年(1987)12月16日
前置審査

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(56)参考文献　特開　昭52－69864（ＪＰ，Ａ）
特開　昭60－253185（ＪＰ，Ａ）
特開　昭59－111902（ＪＰ，Ａ）
特開　昭51－114370（ＪＰ，Ａ）
特開　昭50－1968（ＪＰ，Ａ）

(54)【発明の名称】　極短パルス高電圧加電式ガス浄化装置

１

(57)【特許請求の範囲】

【請求項１】窒素酸化物、硫黄酸化物等のガス状汚染物質を含む浄化すべきガスを導入するためのガス入口と、浄化後のガスを排出するためのガス出口を備えたケーシング内のガス通路に、少なくとも一個をコロナ放電極、少なくとも他の一個を該コロナ放電極と対向した対向電極として相互に絶縁の上配設せる二個以上の独立な電極より成るコロナ電極系を設け、該コロナ放電極と他の電極との間にパルス巾の極めて短い極短パルス高電圧を印加するための容量性エネルギー蓄積要素、その充電用電源及び放電用高速スイッチ要素より成る高圧極短パルス電源を設けた所のガス浄化装置において、該高圧極短パルス電源のパルス巾を１μｓ以下とし、０℃・１気圧におけるガスの密度を１としたときの前記ガスを浄化する際の温度・気圧におけるガスの相対密度をｄとした際、

２

印加する極短パルス高電圧の波高値電圧Vpを、前記コロナ放電極と対向電極間に化学的活性種（ラヂカル）を大量に発生せしめるための臨界の値を示す該コロナ放電極と該対向電極間の距離的平均電界強度をEpoとすると、Epo＝8d（KV/cm）以上となるようにすることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２】特許請求の範囲（１）に記載の装置において、該容量性エネルギー蓄積要素がコンデンサーであることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３】特許請求の範囲（１）に記載の装置において、該容量性エネルギー蓄積要素が高圧同軸ケーブルであることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項４】特許請求の範囲（１）に記載の装置におい

て、該容量性エネルギー蓄積要素がそれぞれ複数個のコンデンサーとインダクタンスのLC梯子型接続回路であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項５】特許請求の範囲（１）より（４）までのいずれかに記載の装置において、該放電用高速スイッチ要素が回転火花スイッチであることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項６】特許請求の範囲（１）より（４）までのいずれかに記載の装置において、該放電用高速スイッチ要素が固定式火花放電スイッチであることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項７】特許請求の範囲（１）より（６）までのいずれかに記載の装置において、該コロナ電極系がコロナ放電極と対向電極のみから成る二電極系であり、該他の電極が対向電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項８】特許請求の範囲（７）に記載の装置において、該対向電極が非コロナ電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項９】特許請求の範囲（７）に記載の装置において、該対向電極がコロナ放電を行うコロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１０】特許請求の範囲（１）より（６）までのいずれかに記載の装置において、該コロナ電極系がコロナ放電極，対向電極の他、該コロナ放電極の近傍に両電極より絶縁されて配設せる第三電極を有する三電極系であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１１】特許請求の範囲（10）に記載の装置において、該第三電極と該対向電極の間に直流高電圧を印加するための直流高圧電源を有し、かつ該極短パルス高電圧を該コロナ放電極と該他の電極としての該第三電極の間に印加することを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１２】特許請求の範囲（10），（11）のいずれかに記載の装置において、該第三電極が非コロナ電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１３】特許請求の範囲（10），（11）のいずれかに記載の装置において、該第三電極がコロナ放電を行うコロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１４】特許請求の範囲（１）より（13）までのいずれかに記載の装置において、該コロナ放電極と該他の電極との間に予めバイアス高電圧を印加するためのバイアス高圧電源を設け、該バイアス高電圧に重ねてこれと同極性の該極短パルス高電圧を結合コンデンサーを介して両電極間に印加することを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１５】特許請求の範囲（14）に記載の装置において、該バイアス高圧電源が直流高圧電源であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１６】特許請求の範囲（14）に記載の装置において、該バイアス高圧電源が該極短パルス高電圧の半値巾よりも十分に長い巾を有するバイアス用パルス高電圧を発生する所のバイアス・パルス高圧電源であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１７】特許請求の範囲（１）より（16）までのいずれかに記載の装置において、該コロナ電極系として該コロナ放電極，該対向電極，該他の電極の中の少なくとも一つの長さが少なくともその上を伝播する該極短パルス高電圧の幾何学的長さの半分以上であり、かつその終端が開放されている様なコロナ伝送線路を用いることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１８】特許請求の範囲（17）に記載の装置において、該コロナ伝送線路を構成する少なくとも一つの長さの長い電極の少なくとも一つ以上の中間点においてピーキング用コイルを挿入することを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項１９】特許請求の範囲（17）に記載の装置において、該コロナ伝送線路の全長を複数個の部分線路に分かち、その下流端の部分線路を除く部分線路が複数個のコロナ放電極の並列接続せるものより成り、かつその並列接続のコロナ放電極数が上流端より下流端に向って逐次減少する如きものであることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２０】特許請求の範囲（１）より（17）までのいずれかに記載の装置において、該コロナ放電極が帯状でかつ入力端から終端に向ってその巾を減ずる如きピーキング用コロナ電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２１】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が断面が円形の線状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２２】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が断面が多角形の線状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２３】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が断面が星形の線状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２４】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極がストリップ状の線状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２５】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が突起付線状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２６】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が突起付棒状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２７】特許請求の範囲（１）より（19）までのいずれかに記載の装置において、該コロナ放電極が突起付ストリップ状コロナ放電極であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２８】特許請求の範囲（１）より（27）までのいずれかに記載の装置において、該極短高圧パルス電源と該コロナ電極系とを高圧同軸ケーブルによって接続し、かつ該同軸ケーブルの長さを少なくともその上で伝播する該極短パルス高電圧の幾何学的長さ以上として、これに分離用伝送線路の作用を付与したことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項２９】特許請求の範囲（１）より（８）まで及び（10）より（28）までのいずれかに記載の装置において、該コロナ放電極及び該対向電極がそれぞれ電気集塵装置における放電極及び集塵極であり、該ケーシングがその下方に補集粒子を受納するためのホッパーと、これを外部に排出するための排出口を有し、排ガスの浄化に加えてガス中の微粒子の電気集塵を行うことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３０】特許請求の範囲（１）より（29）までのいずれかに記載の装置において、該コロナ放電極、対向電極の中少なくとも一者に機械的衝撃を与えるための槌打装置を設けたことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３１】特許請求の範囲（１）より（30）までのいずれかに記載の装置において、該コロナ電極系を電気集塵装置のケーシング内に配設したことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３２】特許請求の範囲（１）より（31）までのいずれかに記載の装置において、該対向電極ないし集塵表面に液膜を形成する手段を具備したことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３３】特許請求の範囲（１）より（32）までのいずれかに記載の装置において、該浄化すべきガスに予め反応促進用添加剤を添加するための添加剤注入装置を備えたことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３４】特許請求の範囲（33）に記載の装置において、該添加剤注入装置がアンモニア注入装置であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３５】特許請求の範囲（１）より（34）までのいずれかに記載の装置において、該浄化すべきガスに予め前処理を施すためのガス前処理装置を備えたことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３６】特許請求の範囲（35）に記載の装置において、該ガス前処理装置がガス冷却塔であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３７】特許請求の範囲（１）より（36）までのいずれかに記載の装置において、浄化後のガスを更に後処理するためのガス後処理装置を備えたことを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３８】特許請求の範囲（37）に記載の装置において、該ガス後処理装置が反応後のガスを吸収するためのガス吸収装置であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【請求項３９】特許請求の範囲（37）に記載の装置において、該ガス後処理装置が集塵装置であることを特徴とする所の極短パルス高電圧加電式ガス浄化装置。

【発明の詳細な説明】

［産業上の利用分野］

本発明はボイラー、焼結機等からの工業排ガス中に含まれる窒素酸化物（以下NOxとよぶ）の酸化・分解、二酸化硫黄（以下SO2とよぶ）の酸化等々によりこれらを含む各種のガス状汚染物質を除去するための、「極短パルス高電圧加電式ガス浄化装置」に関するものである。しかしその応用範囲は単なるガス浄化にとどまらず、電気集塵装置．加電式バグフィル等と組合せてガス浄化と同時に集塵を行なったり、電子複写機、除電器等コロナ放電を用いる装置で発生するNOxの分解等にも利用でき、また一般にガス中の放電化学的反応により特定ガス成分の酸化、還元、生成、分解等を効果的に行なう為にも用いる事ができる。

［従来の技術］

従来、排ガスの脱硝や脱硫に実用されているものは専ら化学的方法である。脱硝には主として300度以上のガス温度で排ガス中にアンモニアを添加の上触媒でNOxを窒素と水分に分解する、いわゆる「アンモニア触媒還元方法が用いられている。また脱硫には主として石灰乳をミスト状にして排ガス中に分散の上、これにSO2を吸収して亜硫酸石膏としてガスから除去する、いわゆる「石灰石膏法」が用いられている。一方排ガスに予めアンモニアを添加の上、これに高エネルギーの電子ビームを照射して、NOxとSO2を硫硝安複塩の固体微粒子に転化し、これをガスから除去する「電子ビーム排ガス浄化方式」も開発された。またこの方式を電子ビームの照射空間に電界を加えて、その反応速度を上げることにより改良する方法もその有効性が実証されている。更に排ガス中に単にコロナ放電極と非コロナ対向電極より成るコロナ電極系のみを設け、両電極間にパルス高電圧を加え、脱硝と脱硫を行なう方式も提案され、実験室規模の装置での有効性が実証されている。しかしこれらはいずれも実用

化が極めて難しく、実用化に成功しないままに現在に至っている。

［発明が解決しようとする問題点］

上記の「アンモニア触媒還元法」、「石灰石膏法」等の化学的方法は建設費・運転費が極めて高く、その上装置の腐蝕、触媒の寿命等の問題がある。「電子ビーム排ガス浄化方法」は脱硝と脱硫を同時に行なうことが出来、触媒も要らず、完全な乾式プロセスなので、装置が簡単で保守も容易であるが、設備費・運転費が共に非常に高い上、放射線防護に高価な対策を必要とする。この方式で電子ビームの照射空間に電界を加えて脱硝・脱硫反応を促進する方式も基本的には電子ビームを使用する事には変わりがないので設備費の高くなるのは避けられない。結局もっとも簡単で経済的な方法は、排ガス中に単にコロナ電極系のみを設けて両電極間に幅の短いパルス高電圧を周期的に印加し、パルス的コロナ放電を発生させ、これによって純電気的に排ガスの脱硫・脱硝あるいはその他の浄化を行なう方法である。しかしこれも大型の装置では全くその効果がないことが認められており、この方式を実用化する為の方策は全く立っていないのが実情であった。

本発明は上記の困難を克服して「極短パルス高電圧によるコロナ放電を用いたガス浄化方式」を大型装置で実用化する事を目的とする。

［問題点を解決するための手段］

本発明は、NOx、SO2等のガス状汚染物質を含有するガス中に、少なくとも一個をコロナ放電極、少なくとも他の一個を該コロナ放電極と対向した対向電極として相互に絶縁の上配設せる二個以上の独立な電極より成るコロナ電極系を設け、該コロナ放電極と他の電極との間にパルス巾の極めて短い極短パルス高電圧を印加する事によりガスの脱硝・脱硫を図る装置において、極短パルス高電圧のパルス巾を1μs以下の値とし、0℃・1気圧における被浄化ガスの密度に対する浄化時の温度・圧力におけるガスの相対密度をdとするとき、該コロナ放電極と該対向電極間の単位長さ当たりの波高値電圧Vpを示す距離的平均電界強度の時間的ピーク値Epが、少なくともガス浄化反応を引き起す臨界値

Epo＝8d（KV/cm） ……（1）

以上となる如き極めて高い値にその波高値電圧Vpの値を選定する事により、上記の問題点を解決する。

ここで、「電圧」はパルスの波高値もしくはピーク値のことを意味するが、本願では、例えばパルスの立ち上がり部分等における電圧と区別するために、波高値（ピーク値）と表現している。

また、平均電界強度とは、周知のように、①静電界における電荷の周囲の電界の強さ、もしくは②時間的に変化する磁場の中に存在する電界の経済的な強さを表わす。本願で述べる平均電界強度は、①の電界強度、すなわち電荷から一定の距離をおいた地点の（ここでは電極間に働く）電界の強さを意味するので、②の電界と混同しないよう、距離的平均電界強度と表記している。

即ち本発明者は、NOx, SO_2等を含むガスのガス通路を横切ってパルス的コロナ放電を発生せしめ、その間隙における距離的平均電界強度が少なくとも上記条件（1）のEpoをこえる如き極めて高い値，好ましくは12d（KV/cm）以上の値をとるようにする事により、はじめてNOおよびSO2をそれぞれ水溶性のNO2およびSO3へと酸化出来、適当な吸収剤ないし吸収液，例えば水やNaOH, Na2CO3, Ca（OH）2, CaCO3の水溶液又は懸濁水への接触吸収によりガス中から有効に除去できる事を見出した。この場合かかるNO2, SO3等の吸収液は、該対向電極の表面に液膜の形で流下せしめると、もっとも有効かつ好適である。またNOの酸化で生成したNO2は更に極短パルス高電圧によるパルス的コロナ放電の作用で分解されるが、この際予めガス中にNOxと等量のアンモニアを添加しておく事によりNO2の分解が著しく促進される事が見出された。またSO2やSO3もアンモニアの添加により固体微粒子に転化固定される事が見出された。またNOxとSO2がガス中に共存する時には、正パルスコロナを用いる際先ずNOxの酸化・分解が先行し、しかる後SO2の酸化が行なわれる事が判明した。またガス中に含まれる水銀蒸気も上記パルス的コロナ放電により極めて有効に酸化されて固体の酸化水銀となり、またHCL等の存在下に可溶性の塩化水銀となることが知られている。

また本発明によるNOの酸化, NO2の分解, SO2の酸化，水銀蒸気の酸化や塩化等の放電化学的ガス浄化反応はガス通路におけるコロナ放電極と対向電極間の距離的平均電界強度を上記（1）式のEpoを越えて更に高くすればする程、またコロナ放電極の曲率半径を小さくしたり、鋭い突起をつけてパルス・コロナ放電を活発ならしめる程、より効果的におこなわれることも判明した。

上記（1）式のEpoを越える著しく高い距離的平均電界強度を、火花の発生なしに上記ガス通路のコロナ空間に形成するには印加すべき上記極短パルス高電圧の幅を極めて短くする必要がある。この場合パルス巾を半値巾Tpであらわすと、その所要値は用いるコロナ電極系の構成・電極形状・寸法やガスの組成・温度・圧力等に依存するが、通常Tpを長くても1000ns以下、好ましくは500ns以下と極度に短くする必要がある事が実験により見出された。

本発明に用いるコロナ電極系としてはガス通路を隔てて互いに対向した該コロナ放電極と該対向電極の二種類の独立電極から成る二電極系を用いてもよく、また放電極の近傍に更に第三の電極を絶縁配設した三電極系を用いてもよい。また本発明に用いる該コロナ放電極としては線状・角線状・刺付き線状・突起付き棒状・ストリップ状・突起付きストリップ状等、適当な如何なる形状・構造・材質のものを用いてもよいが、上述の通りコロナ放電が活発におこる様な形状にするほど放電化学作用が

旺盛となるので一般には好適である。またこのコロナ放電極を適当な支持枠に固定して用いても、また一本の長いコロナ伝送線路を形成せしめて用いてもよい。

本発明の電極構成として上記二電極系を用いるときは、その対向電極として上記の様なコロナ放電極を用いてもよく、また板状・金網状・円筒状等の曲率半径の大きな非コロナ電極を用いてもよい。また三電極系を用いる時は対向電極として上記の様な非コロナ電極を用いるのが好適であり、第三電極としてはコロナ放電極、非コロナ電極のいずれを用いる事も出来る。

二電極系の使用にあたっては該コロナ放電極と対向電極間に直接該極短パルス高電圧を印加してもよいが、予め両電極間に加えるべきパルス高電圧と同極性の補助高電圧（以下バイアス高電圧とよぶ）を加えておき、これに重ねて該極短パルス高電圧を結合コンデンサーを介して印加すればその波高値電圧を該バイアス高電圧の分だけ低減出来て極短パルス高電圧を発生するための極短高圧パルス電源を安価に出来、好適である。

三電極系の使用にあたっては、上記バイアス高電圧を該第三電極と該対向電極の間に前者の後者に対する極性が該コロナ放電極の該パルス高電圧における極性と同じになる様にして印加しておき、その上で該コロナ放電極と該第三電極の間に直接または結合コンデンサーを介して該パルス高電圧を印加する。

二電極系および三電極系において使用する上記バイアス高電圧は直流高電圧を用いてもよいが、該極短パルス高電圧よりも幅の広いパルス高電圧（以下バイアス・パルス高電圧とよぶ）を用いるとバイアス直流高電圧を用いる場合と異なり、ガス通路空間を横切って流れるイオン電流を大幅に低減出来、脱硝・脱硫等のガス浄化に要する消費電力を著しく節減できる。

上記二電極系および三電極系において該対向電極を非コロナ電極とする場合、極短パルス高電圧を印加する際の該コロナ放電極の極性は正・負いずれであってもよいが、正のパルス・コロナはストリーマー状に伸びて該コロナ放電極と相手電極間のガス空間を橋絡するので、脱硝・脱硫等のガス浄化反応を生起せしめるもとになる化学的活性種が空間全体に生成され、比較的小さな装置容積、ないし短かい滞留時間内にこの反応を完了出来、設備を小型化する事が出来る。したがって本発明をガスの脱硝・脱硫等のガス浄化のみの目的で単独に実施するには正パルス・コロナ放電を用いた方が設備費を安く出来る。特にSO_2のSO_3への酸化速度は負のパルス・コロナでは極めて遅いので、正のパルス・コロナを用いる必要がある。

しかし本発明のコロナ電極系を電気集塵装置として兼用し、該コロナ放電極をその放電極、該対向電極をその集塵極とし、排ガスの脱硝・脱硫等のガス浄化と同時に集塵を行なう事も可能で、その場合には該コロナ放電極にその極性を負として極短パルス高電圧を印加し、負のパルス・コロナ放電発生させるのが好適である。何故ならば、正パルス・コロナ放電を用いる時は、上述の如く放電がコロナ放電極と集塵極間の間隙をストリーマー状に橋絡して間隙空間全体に正・負イオンを成生するので、単極性イオンのみの射突を必要とするダスト粒子の荷電が行なえず、集塵作用が失われるからである。これに対して、負のパルス・コロナ放電を用いると放電はコロナ放電極近傍に局限され、この領域のみで正負イオンを形成するが、それ以外の領域では負イオン流のみが存在するので、ダストの荷電・集塵が有効に行なわれ得る。この場合本発明を通常の放電極と集塵極より成る二電極式の電気集塵装置を兼用せしめて実施する時は、コロナ電極系の電極構成は上記二電極系となり、両電極間に予め該コロナ放電極を負とする直流高電圧をバイアス直流高電圧として印加し、これに重ねて結合コンデンサーを介して該極短パルス高電圧を該放電極を負とする極性で印加するとよい。また本発明はコロナ放電極・集塵極に加えて該コロナ放電流の近傍に非コロナ電極ないしコロナ電極より成る第三電極を設けた三電極式の電気集塵装置としても実施でき、この場合は該第三電極と該集塵極の間に前者を負とする直流高電圧を印加し、該放電極と第三電極の間に前者を負とする極性をもって該極短パルス高電圧を印加する。

本発明で使用する極短パルス高電圧は、コロナ電極系を長い伝送線路（以下コロナ伝送線路とよぶ）として構成すれば、その上を進行波として伝播しつつ強力なコロナ放電をその全長にわたって発生し、該極短パルス高電圧の保有するエネルギーを最も有効にコロナ放電の形成、したがって脱硝・脱硫等のガス浄化反応に利用する事ができる。この場合パルス電圧の伝播速度はほぼ光速C_0に等しいので、パルス電圧の巾がTの時、その幾何学的な長さは$L_p = C_0T$になるので、終端開放のコロナ伝送線路の場合その長さL_0が（1/2）L_pと同等もしくはこれよりも長いこと

$$L_0 \geqq (1/2) L_p \qquad (2)$$

がパルス電圧が進行波としてのふるまいを見せるための条件であり、反対に$L_0 \ll (1/2) L_p$の時はコロナ電極系は電極間容量とコロナ放電の等価並列抵抗より成る所の集中定数負荷となる。

この進行波を用いる本発明の実施態様（以下進行波型とよぶ）を該二電極系のコロナ電極系ないし二電極式電気集塵装置で実施するにあたっては、長い線状の該コロナ放電極を、一対の並行な接地せる板状の対向電極（ないし集塵極）の間にジグザグ状に線間幅ほぼ５ないし30cmをもって絶縁配設するのが好適で、この場合互いに向い合った一対の接地対向電極（ないし集塵極）とその中間に配設された一本の長いコロナ放電極が組になって並列の二つのコロナ伝送線路を構成する。この場合該コロナ放電極は大地より絶縁せる適当な支持枠に、これより絶縁して取り付けるのが好適である。

また該進行波型を三電極系のコロナ電極系または三電極式電気集塵装置で実施するにあたっては、該コロナ放電極あるいは該第三電極の少なくとも一方を、互いに向き合った一対の平行な接地せる板状の対向電極（ないし集塵極）の中間にジグザグ状に該第三電極とコロナ放電極間の間隔約２ないし10cmをもって絶縁配設するのが好適で、この場合には該コロナ放電極と該第三電極および該コロナ放電極と両対向電極（または集塵極）とがそれぞれ並列の三つ（ないし四つ）のコロナ伝送線路を形成する。この場合第三電極をすのこ形として支持枠を兼ねさせ、すのこの相隣る垂直柱の中間を走るごとく蛇行して該支持枠より絶縁の上該コロナ放電極をジグザグ状に配設するのが好適である。

コロナ伝送線路上を上記の極短パルス高電圧が進行波として進行し、その途中においてコロナ放電を行う時は、それに伴うエネルギー損失のため該極短パルス高電圧の波高部分が次第に欠損して行き、或る距離進行した後は完全に波高部が失われて、もはやコロナ放電を生ずる能力が消失する。この距離は条件によって異なるが、負パルス電圧の場合約300m,強力なストリーマー状コロナ放電を発生するエネルギー消耗の激しい正パルス電圧の場合約3m～10m程度である。ところで波高部が消失した後も該極短パルス高電圧は尚充分なエネルギーを保有しており、これを有効に活用するため何等かの方法でその波高部を再び持ち上げて（以下これをパルスピーキングと略称する）コロナ開始電圧値以上とし、パルス高電圧保有エネルギーの大部分をコロナ放電のエネルギーに転換してやることが、本方式の電力効率を高め、運転コストを下げる上げ極めて重要である。パルスピーキングを実施するための一つの方法はコロナ伝送線路のサージンイピーダンス

$$Z_o = \sqrt{L/C} \qquad (3)$$

を下流に行くほど大きくしてやると良く、そのためにはコロナ伝送線路単位長当りのインダクタンスＬを下流に行くほど大きくするか、コロナ伝送線路単位長当りの線路間静電容量Ｃを下流に行くほど小さくしてやれば良い。これを本発明において最も簡単に実施する方法は長いコロナ放電線の途中にいくつかのインダクタンス要素（以下ピーキング・コロナと省略する）を挿入し、そのインダクタンス値を下流に行くほど大きくすると共に、コロナ伝送線路の終端を開放すること（この時Zoは無限大となり、進行波は全反射する）である。またコロナ放電線をいくつかの放電線を並列接続して構成し、その並列線数を途中のいくつかの場所で減じて遂に一本とした上で線路終端を開放してもよく、この時は上記のＣがその度に減少してZoが上昇する。あるいはコロナ放電線をうすい帯状の導体で作って対向電極に並行に配置、その鋭い周縁部でコロナ放電を発生させる様にし、かつその巾を入力端から終端に向かって逐次狭くして行って対向電極に対する静電容量Ｃを減じ、終端で巾をゼロとすると共に開放端としてもよい。以下この様なコロナ放電極をピーキング放電極と呼ぶことにする。以上の他パルスピーキングは適当な方法でパルスの巾を圧縮して小さくすること（これをパルス圧縮という）によっても行うことが出来、本発明のコロナ伝送線路において、パルス圧縮を適用してパルスピーキングを実施してもよいことは云うまでもない。

脱硝・脱硫等のガス浄化に要する時間は印加する極短パルス高電圧の周波数fpにほぼ反比例するので、fpの値を高くする程、装置を小型化できる。本発明の実施にあたっては実用上fpを50Hz以上、好ましくは250Hz以上に選定するのがよい。

この様な極度に巾の短い極短パルス高電圧を発生する為の高圧極短パルス電源としては、適当な如何なるものを利用しても良いが、一般にエネルギー蓄積要素（パルス波形成形要素ともよぶ）としてコンデンサー，同軸ケーブルあるいは複数個のコンデンサーとインダクタンスを梯子型に接続したLC梯子型回路等の容量性エネルギー蓄積要素を用い、これに直流高電圧をもって充電し、ついでこれを固定火花ギャップ、回転火花ギャップ、あるいは水素サイラトロン等の高速スイッチ素子をもって瞬時に負荷である本発明のコロナ電極系の両電極間に直接又は結合コンデンサーを介して放電して該極短パルス高電圧を形成する形式のもの（容量蓄積型と称する）を用いるのが好適である。しかしエネルギー蓄積要素としてインダクタンスを利用し、そのコイルに予め直流電流を流しておいて、その電流を高速スイッチ素子で瞬時に開放、この時該インダクタンス両端に現れるパルス高電圧を本発明の負荷に直接又は結合コンデンサーを介して印加する形式のもの（インダクタンス蓄積型と称する）を用いても良い。容量蓄積型高圧極短パルス電源で固定火花ギャップを用いる時は、コンデンサー等の容量性エネルギー蓄積要素の充電過程における電圧が、ギャップの火花電圧を越えた時、火花ギャップを自憬せしめる自爆型火花ギャップを用いてもよいが、例えば主火花電極の他トリガー電極を有する三点火花スイッチを用いると、所要の時点にトリガー電極にトリガー用パルス電圧を与えることにより火花を発生せしめてスイッチ作用を発現させることが出来る。この様な外部トリガー型固定火花スイッチはまたトリガー用レーザービームを所要の時点に火花電極に照射することでも構成でき、その照射の瞬間に火花を発生せしめうる。高速スイッチ素子としてこの様な外部トリガー型固定火花スイッチ、回転火花スイッチ、水素サイラトロン等を用い、上記容量性エネルギー蓄積要素を直流高電圧でなく交流高電圧をもって半波整流器を介して充電し、該交流高電圧が充電を完了のの

ちゼロ電圧値付近をとる瞬間、ないしは極正反転して該半波整流器がブロックしている半周期内にのみ該高速スイッチ素子をオンせしめる様にする時は、この瞬間の電源から負荷への突入電流の発生を防止できると共に、交流充電固有の利点として充電損失を大幅に減少でき、高圧極短パルス電源の電力効率を大幅に向上できる。

次に本発明の極短パルス高電圧をコロナ伝送線路でない通常のコロナ電極系に印加するに際しては、該コロナ電極系が電極間静電容量とコロナ損失に伴う並列高抵抗よりなる集中定数負荷としてふるまい、この容量と高圧極短パルス電源の静電容量、そのインダクタンス分、及びスイッチ素子及び該電源とコロナ電極系を接続するフィーダー回路のインダクタンスによって高周波のLC連成振動が発生し、火花電圧が大幅に低下する。

そこでこの連成振動発生を防いで火花電圧を上昇させ、安定に式（１）のEpoよりも高い距離的平均電界強度をガス間隙間に実現するには、パルス電源とコロナ電極系の間にパルス電圧の幾何学長と同等又はそれ以上の長さをもった長い高圧同軸ケーブル等の伝送線路を挿入し、一旦パルス電圧を進行波にしてこの線路上を伝播せしめた上、その終端でコロナ電極系に印加するようにして、電源側と負荷側の回路的相互干渉を分離するとよい。以下この様な伝送線路を分離様伝送線路とよぶことにする。この分離用伝送線路は本発明に用いるコロナ電極系が集中定数負荷であるとき上記連成振動をおこすのを防止し、極短パルス高電圧波がそのままの形で負荷に加わる様にするために必須の要素であって、かかる分離用伝送線路を用いることも本発明の一つの特徴をなす。この場合、容量性エネルギー蓄積要素としてパルス波形成形用コンデンサーを用いる時は、その充電電圧はスイッチ素子を介して該分離用伝送線路の入力サージインピーダンス（純抵抗分よりなる）に放電し、その時に生ずるCR－減衰波形が進行波として速度

$$V = 1 / \sqrt{LC}$$

で伝送線路上を伝播する。したがって分離目的を達するには線路の長さLsはパルスの巾をＴ（ns）とすると、

$$Ls \geq VT \quad (4)$$

とする必要がある。いまかかる分離用伝送線路として高圧同軸ケーブルを用いることとし、その上での進行波伝播速度Ｖの値をＶ＝0.2m/nsとすると、Ｔ＝500nsの時にはLs≧100m,T＝1000nsの時にはLs≧200mとする必要がある。

［作用］

本発明の特長をなす式（１）のEpoよりも大きい距離的平均電界強度を短時間乍らコロナ電極系の電極間に形成する時はコロナ放電に伴って発生した電子が一平均自由行程内に強力に加速されて著しく高い運動のエネルギーを獲得し、ガス中に含まれるO_2,H_2O等の分子と衝突の上、脱硫・脱硝等のガス浄化反応を引き起こすもとになるOHラヂカル,O,O_3,励起状態の酸素およびO_2イオン等の化学的活性種を大量に成生させ、その強力な酸化作用によって例えばNOはNO2,SO2はSO3,水銀蒸気は固体の酸化物に直ちに酸化され、適当な吸収剤の水溶液で容易にガスから除去できる。また予め中に適当な添加剤、例えばNOやSO2の場合アンモニアガス，また水銀蒸気の場合塩化水素ガス等を添加する時は上記強力なエネルギーを有する電子の放電化学的作用で例えばNO2の大部分を分解し、SO2はNH3と結合せしめて固体の硫安微粒子に転化固定、また水銀蒸気はその固体の塩素化合物に転化固定することが出来るので、ガスからNOx,SO2,水銀蒸気等の汚染物質を完全に除去することが可能となる。すなわち本発明に固有の極めて高い脱硝・脱硫等のガス浄化効果の基本的作用機構は、本発明がはじめて一平均自由行程内で、今迄到底不可能なレベルまで電子を加速してそのエネルギーを著しく上昇せしめ、これによって従来の壁を超えて脱硝・脱硫反応を含むガス浄化反応や放電化学的反応の速度と収率を飛躍的に向上せしめ得たことにあるのである。

［実施例］

第１図は本発明によるガス浄化装置を特に排ガス脱硝・脱硫装置として利用せるものの一実施例の縦断面図、第２図はその横断面図を示す。１はNOx,SO2を含むガスの入口2,硝酸・脱硫後のガスの出口3,ホッパー4,ダスト排出口５を有する接地された金属より成るケーシングである。その内部に等間隔で接地せる垂直平行板状対向電極群6,6′が配設されており、ケーシング及び該対向電極群の中間に絶縁配設され矩形状金属支持枠群７に支持張架された線状のコロナ放電極群８がある。該支持枠７は下方においては水平ビーム９上に固定された支持碍子により、上方においては碍管11を貫通する金属支柱12により支持されて、大地より絶縁されている。該支柱12の一つは切替スイッチ13を介し、本例の図では更に塞流インダクタンス14を経て出力電圧Vbのバイアス直流高圧電源15の正極性出力端子と接続され、更に結合コンデンサー16,高圧同軸ケーブル17を介して極短高圧パルス電源18の正の出力端子に接続されている。このパルス電源18の発生する極短パルス高電圧は、そのパルスの半値巾Tpが500ns以下でその波高値電圧Vpが充分に大きく、上記バイアス電圧Vbと重畳せる全波高値電圧（Vp＋Vb）が式（１）で与えられるEpoよりも充分大きい距離的平均電界強度を与えて本発明の要件を充分に満足せしめるものである。また本例にあたっては該コロナ放電極群８と対向電極群6,6′より成るコロナ電極系は集中定数回路を形成しており、したがって該高圧同軸ケーブル17はすでに述べた分離用伝送線路の役目も果している。すなわち該同軸ケーブル17の長さLsは式（４）を満たす様充分長くとってある。いま切替スイッチ13を左に投入すると、バイアス直流高圧電源15が切り離され、極短高圧パルス電源18の出力電圧が結合コンデンサー16を介さずに

直接コロナ放電極群７と対向電極群6,6′の間に印加される。20はアンモニア容器で、注入パイプ21を介してアンモニアガスがノズル22より入口ダスト23内に吹き込まれる。NOx,SO2を含むガスは入口２より進入、ノズル22より吹き込まれたNOx,SO2の合計せるものと化学的に当量のアンモニアガスを混入ののち、コロナ放電極群７と対向電極群6,6′の間のガス通路19を上方に流れ、出口３に至り、これより硫化微粒子除去用の適当な集塵装置へと導かれ、硫安微粒子を除去せるのちスタックへと排出される。上記極短パルス高電圧の印加によってコロナ放電極群８より対向電極群6,6′に向ってガス通路19を橋絡する強力なストリーマー状の正コロナ放電が発生し、その強力な放電化学作用によって、NOxはアンモニアの存在下にその大部分がN2とH2Oに分解し、SO2は酸化されてSO3に酸化されたのち、NH3と化合して硫安の固体粒子となる。その一部は下方のホッパー４に落下してここに堆積し、ダスト排出口５より外部に排出される。残りの微細硫安粒子はガスに同搬されてガス出口３に至り、外部に導かれる。

該高圧同軸ケーブル17は全長150mですでに述べた分離用伝送線路の役目をかねており、その上でのパルス電圧の伝播速度は0.2m/ns,パルス巾500ns、したがって分離用伝送線路としての式（４）の条件を満たす。その結果、本例におけるコロナ電極系は巾500nsのパルス電圧に対しては容量性の集中定数負荷であるにも拘らず、ケーブル上を伝播して来た極短パルス高電圧がほぼそのままの波形でコロナ放電極群８と対向電極群6,6′の間に印加される。次に反射されてケーブル17上を同一極性のパルス電圧としてパルス電源へと戻り、以下多重反射を繰り返す。但し該極短パルス高電圧の急峻な立上り部分は高い高周波成分を含むので容量性集中定数負荷があるコロナ電極系から反射される際、容量分がほぼ短絡として働く。したがってこの部分のみ極性反転し、反射正パルス波はその立上り部分のみにヒゲ状の負の極めて短いパルス部分を含んだものとなる。24は電荷漏洩用高抵抗でケーブルの心線に直流電荷が蓄積するのを防止する。

本例でアンモニアを注入する代りに対向電極6,6′の上方から吸収液として水,NaOH・Na2CO3・CaOH・CaCO3等の水溶液ないし懸濁水を供給し、これを6,6′の表面に沿って面上を流下せしめて液膜を作り、NO2,SO3等の生成酸化物をこの上に吸収せしめてもよく、この時は極めて高いガス浄化効果が達成できます。

第３図は第１図及び第２図の実施例においてコロナ電極系を接地ケーシングを兼ねた垂直の円筒状対向電極25とその軸上に絶縁張架された一本の線状コロナ放電極８のみをもって構成した、本発明による小型排ガス脱硝・脱硫装置の縦断面図である。図における２より17に至る番号の要素の名称と機能は第１図，第２図における同一番号の要素のそれと同じであり、更に本図においてはパルス電源18,アンモニア容器20,同注入パイプ21,注入ノズル22は省略して画かれていない。アンモニアガスを添加ののちガス入口２より導入されたNOx,SO2を含むガスはケーシングを兼ねた円筒状対向電極25の内部のガス通路19を上昇中にコロナ放電極８より25に向けて生ずる正のパルス状のストリーマー・コロナ放電の極力な放電化学作用で脱硝・脱硫反応を完了し、ガス出口３より外部に排出される。この場合にもアンモニア注入の代りに円筒状対向電極25の内壁上にNO2,SO3等反応生成物の吸収液の液膜を作り、この液膜にこれら反応生成物を吸収せしめてもよいことは云うまでもない。

第４図は第１図，第２図の実施例において支持枠７を取り除き、線状のコロナ放電極群８を上方では上部支持碍子26に絶縁支持された上部水平支持導体27に固定し、下方では下部支持碍子10に絶縁支持された下部水平支持導体28に絶縁物29を介して固定張架して構成した本発明の一実施例である。

図における他の番号の要素の名称と機能は、第１図および第２図の同一番号の要素のそれと同じであり、また第１図，第２図におけるこれ以外のすべての要素（７を除く）は本例においても存在するが省略してあり画かれていない。第１図，第２図がコロナ電極系を集中定数系として使用しているのに対して、本例では立上りがより急峻で巾のより短い正の極短パルス高電圧を正のバイアス直流高電圧に重ねて、あるいは単にそのままで印加使用し、該極短パルス高電圧を進行波として用いる所に特徴がある。すなわち切替スイッチ13を介して支柱12よりケーシング１内に侵入した極短パルス高電圧の波頭は上部水平支持導体27を介して長さ約6mのすべての線状コロナ放電極群８に分配され、矢印30の方向に下方に進行する。そしてその間に対向電極群6,6′に向って強力なストリーマー状の正コロナ放電を生じ、その際急激にエネルギーを失って波高部が欠損するため、約3m進行するとコロナ発生能力を失う。しかし更に3m進行すると絶縁物29で支持された開放状態の下端部に至り、ここで該パルス高電圧は同一極性に全反射され、進入波と反射波が重なって波高値が約２倍に持ち上がり、ピーキングを生ずる。その結果再びパルス発生能力を回収し、反射波は上方に向って進行しつつ約3mほどの間強力なストリーマー状の正コロナ放電を生ずる。その結果全長6mの角コロナ放電極がその全体に渡って強力な正コロナ放電を生じて有効に脱硝・脱硫作用を行なうこととなる。

この様に正パルス高電圧を進行波として用いる場合は、正コロナ放電による波高部の減衰が著しいので、終端を開放としてピーキングを併用することが不可欠である。それでもコロナ伝送線路を余り長くすることは意味がなく、高々全長は６～10m程度におさえないとコロナ放電線の中間部にコロナ放電の発生しない部分が生ずる。したがって大量のガスを処理するには、コロナ電極系の並列電極数を増す他はなく、場合によりケーシング１を上方に延長してこの部分に同じ構造のコロナ電極系

を上部水平支持導体27を共通として対称状に反転配置せるものを配設し、滞留時間を長くする必要を生ずる。勿論この場合には碍管11をケーシング１の側壁に設けねばならない。また本例でバイアス直流高圧電源の出力電圧と極短高圧パルス電源の出力電圧を負極性とすると、各コロナ放電線８の長さは6mであり、また負パルス電圧の線上での伝播中のコロナ放電に伴なう減衰ははるかに少ないので、コロナ電極系は集中定数回路として働く。そこで使用する高圧ケーブル17（図に示されていない）を充分長くして分離用伝送線路とする必要がある。この時放電極群８にはバイアス直流高電圧に重ね極短パルス高電圧がそのままの波形で印加され、脱硝・脱硫を行なうと共に、排ガス中に含まれたダスト及び生成硫安粒子を荷電してこれを電気集塵作用で対向電極群6,6′上に捕集する。またスイッチ13を左に投入すると負の極短パルス高電圧が直接コロナ電極系に印加され、負コロナ放電を生成するのみならず、該コロナ電極系の電極間静電容量を充電して直流電界を形成、やはり電気集塵作用を生ずる。但しこの場合、コロナ放電極近傍のコロナ放電域から負イオンが対向電極に向って移動、負イオン電流を生ずることにより、上記電極間静電容量に貯えられた電荷が放電されてコロナ放電極８の電圧はCR減衰を示すので鋸歯状態となり、その頂部に急峻な極短パルス電圧の重なったものとなる。またケーブル17を短くしたり省略するとコロナ放電極の電圧波形は上記鋸歯状波に、その波頭部ですでに述べた連成振動による高周波減衰振動の重なったものとなる。

第５図は負の極短パルス高電圧を用い、その全長Loが式（２）の条件を満足する様な長い一本の線状コロナ放電極８を相対する接地対向電極群6,6′の中間にジグザグ状に張架し、かつ終端を開放としてコロナ伝送線路とし、パルス電圧を進行波として伝播させつつ負コロナ放電を行わしめる方式の本発明による排ガス脱硝・脱硫装置の縦断面図で、本例ではこの装置が電気集塵装置を兼ねている。図においてケーシング１内に接地配設された垂直対向電極群6,6′は集塵極を兼ねており、絶縁された金属支持枠７に碍管3,下部絶縁物29,上部絶縁物32を介して張架固定された線状コロナ放電極群８は、交互に下部接続導線を兼ねたピーキング用コロナ33,上部接続導線を兼ねたピーキング用コロナ34で接続されて、ジグザグ状の長い終端開放のコロナ伝送線路35を形成すると共に電気集塵装置の放電極を兼ねている。

そして各対向電極間に多数並列に配設されたコロナ伝送線路群35は入力端36の上方でこれらと接続された分配用共通導線37,碍管38を介して切替スイッチ13に接続され、本例の図では塞流インダクタンス14を介してバイアス直流高圧電源15の負の出力端子に接続されるとともに、結合コンデンサー16,高圧同軸ケーブル17を介して、図には示されていない高圧極短パルス電源18の負の出力端子に接続されている。これによりコロナ電送線路35には常時負の直流バイアス高電圧が印加され、これに重ねて負の極短パルス高電圧が碍管38をへて進行波としてケーシング１の内部に進入、共通導体37を介して分配されたのち各コロナ伝送線路35の入力端36に印加され、35の上を矢印39の方向にジグザグ状に進行しつつ負コロナ放電を全長にわたって発生、その放電化学作用で予めアンモニアを添加ののち入口２よりケーシング１内に進入せるNOx,SO2を含む排ガスの脱硝と脱流を行う。またこの時負コロナ放電で生じた負イオンがガス中に浮遊したダストに射突してこれを強力に負に荷電し、そのためダストはクーロン力によってガスから分離し、対向電極をかねた集塵極群6,6′の表面に捕集される。この際SO2がSO3に酸化され、更にNH3と結合して生じた硫安微粒子も同様に電気集塵作用により6,6′の表面に捕集される。したがって該集塵極群6,6′に槌打装置40により機械的衝撃を与えることにより捕集されたダスト層は下方に落下し、ホッパー４内に受納される。この場合硫安粒子はその粒径が極めて細かく、コロナ放電極群８にも堆積し、コロナ放電を抑制する傾向があるので別の槌打装置41により、８の支持枠７を槌打してこれを除去する。NOx,SO2およびダストを除去された清浄ガスは直接スタックへと導かれる。負極性の進行波パルス高電圧は正極性のそれに比べて電極間を橋絡する様な長いストリーマー状のコロナ放電を発生せず、コロナ放電はコロナ放電極の近傍領域に限定される。したがってガス通路はコロナ放電領域から対向電極に向って流れる単極性の負イオンのみに満され、正のストリーマー・コロナの様にガス間隙全体が粒子電荷を除電する作用をもった正負両極性イオンで満たされることが少ない。その結果負コロナ放電ではガス通路のほぼ全域でダスト粒子への負イオン射突による荷電が可能となり、電気集塵作用が発現する。すなわち、本発明による脱硝・脱硫装置をして電気集塵装置を兼ねしめるためには負の極短パルス高電圧を用いることが不可欠の条件である。しかし上述の如く負コロナがコロナ放電極の近傍域のみに局限されるので（１）その領域内でしか脱硝・脱硫が行われず、空間の利用効率が悪いので大きなスペース、長い滞留時間が必要となる。（２）またコロナの局在に伴う分だけ、コロナ放電極単位長当りのエネルギー消費が少く、コロナ放電に伴う極短パルス高電圧の波高部の欠損が正パルスに比べて格段に少くなる。換言するとコロナ伝送線路上のコロナ放電成正可能な有効長が長くなる。しかし（１），（２）の特性は脱硝・脱硫を大容積の電気集塵装置内で行なう場合にはむしろ好都合である。勿論この場合終端を開放してピーキングを行う必要があることは正の極短パルス高電圧を用いる場合と同じである。

本例で切替スイッチ13を左に投入すると負のバイアス直流高圧電源15が切りはなされ負の極短パルス高電圧が直接ケーブル17から分配用共通導体37を介して各コロナ伝送線路35に印加され、その上を進行波パルス高電圧と

して伝播する。この場合パルス高電圧の波高値を充分高くしておくと強力な負コロナ放電を発生して脱硝・脱硫作用を発揮する。またすでに述べた理由でコロナ放電極８の電圧はCR減衰による負の鋸歯状波電圧の波頭部に急峻なパルス電圧、又は高周波の減衰振動（ケーブル17を短くするか、とり除いた場合）が重なったものとなり、電極間のガス通路に直流電界成分があらわれて、ダストと生成硫安粒子の電気集塵が行われる。本例において下部のピーキングコイル33のインダクタンス値よりも上部のピーキングコイル34のインダクタンス値の方が大となっており、これによって挿入点での伝送線路のサージインピーダンスを順次に上げてパルス電圧のピーキングが行われる。その結果伝播中のコロナ放電によりパルス波高部が次第に失われ、コロナ放電が弱まるのを防止することが出来る。この様なピーキングは以下に示す様な別の方法でも実行できる。

すなわち第６図（ａ）は第５図の実施例においてコロナ伝送線路35を複数個の並列接続せる線状コロナ放電極８のグループ（以下段とよぶ）を、更に直列接続して形成し、その並列コロナ放電極数を順次減少して伝送線路のサージインピーダンスを上昇することによりパルス電圧のピーキングを行ったものである。本例では第一段の線状コロナ放電極部42が金属支持枠７に固定せる上下の絶縁物32、29に絶縁支持された上下水平支持導体43、44に張架固定せる３本の線状コロナ放電極８の並列接続されたのから成り、第２段45は同様の上下の水平支持導体43′,44′に張架せる２本の並列接続せる線状コロナ放電極８′、第３段46は上下で絶縁物32、29に張架固定せる１本の線状コロナ放電極８″より成り、それぞれ下端と上端で接続導線33′,34′により水平支持導体44と44′，及び43′とコロナ放電極８″の上端が接続されることにより42,45,46の各段が直列接続されて、入力端36より終端47に向って３段階にサージインピーダンスが上昇する終端開放のコロナ伝送線路35を形成している。これによりコロナ放電によって波高部を欠損した進行波パルス電圧の充分なピーキングが行われ、該コロナ伝送線路の全長にわたり均一かつ旺盛な負コロナ放電があらわれる。同図における上記以外の番号の要素の名称と機能は第１図，第２図，第５図の同一番号の要素のそれと同じである。ただしアンモニアの容器20,注入パルス21,注入ノズル22,切替スイッチ13につながる塞流インダクタンス14,バイアス直流高圧電源15,結合コンデンサー16,高圧同軸ケーブル17,高圧極短パルス電源18は省略されて本図には画かれていない。

第６図（ｂ）は第６図（ａ）において並列線状コロナ放電極数を逐次減じてピーキングを行う代りにコロナ放電極8a,8a′の巾を上方から下方に向けて減ずることにより、これらの対向電極6,6′に対する静電容量を減じ、サージインピーダンスを連続的に下方に向けて高めてピーキングを行ったもので、本例の方式は特に正の極

短パルス高電圧の印加時にそのピーキングを簡単に行う方法として適している。この様なコロナ放電極8a,8a′をピーキング一放電極という。図における8a,8a′以外の番号の要素の名称及び機能は第６図（ａ）の同一番号の要素のそれと同じであり、更に図においては塞流インダクタンス14,正のバイアス直流高圧電源15,正の高圧極短パルス電源18及び高圧同軸ケーブル17が省略されて画かれておらない。

第７図は本発明のいま一つの実施例の縦断面図でコロナ放電極８と非コロナ第三電極47及びこれらの両側の一対の対向電極6,6′をもって三電極式コロナ電極系を構成し、かつこれを長いコロナ伝送線路35として構成し、排ガスの脱硝・脱硫・集塵を行う様にした装置である。図において中間に垂直支柱48′を有する非コロナ第３電極47を兼ねた金属支持枠７の相隣る垂直金属柱群48,48′,48″の中間に、線状コロナ放電極8,8′がこれと平行に、これより絶縁されて配設され、支持枠７の上下の水平支持導体27,28を貫通する碍管31,49,50及び27に固定された上部絶縁物32によって張架固定され、かつ接続導線33′によって直列接続されて一本の長い終端開放の線状コロナ放電極を形成し、それぞれの両側の一対の非コロナ第三電極48－48′,48′－48″及び一対の対向電極6,6′との間に４個の部分コロナ伝送線路を形成し、これらが並列接続された一つのコロナ伝送線路35を形成している。金属支持枠７は支柱12,導線58,スイッチ51,塞流インダクタンス14を介してバイアス直流高圧電源15の負の出力端子に接続されており、その負のバイアス直流高電圧は二連切替スイッチ52,導線53,漏洩用高抵抗54を介してコロナ放電極８にも印加されている。いま絶縁された高圧極短パルス電源18から導体外皮55が絶縁された高圧同軸ケーブル17の心線56と外皮55,導線53,二連の切替スイッチ52および導線57,58を介して供給された極短パルス高電圧は，分配用共通導体37及び金属支柱12を介して長いコロナ放電極８の入力端36と金属支持枠７の左上端59間に前者を負とする極性で印加され、次いで８－48,8－48′,8－6,8－６′からなる並列コロナ伝送線路、次いで８′－48′,8′－48″,8′－6,8′－６′からなる終端開放の並列コロナ伝送線路を進行波パルス高電圧として伝播し、その間に主として８より48,48′，また８′より48′,48″に向って強力な負コロナ放電を行い、排ガスの脱硫・脱硝を行う。またこの際生じた負イオンはガス通路にバイアス直流高圧電源15の作用で形成されている直流電界の作用で対向電極6,6′へと駆動され、この間に排ガス中のダスト及び生成硫安粒子に射突してこれを負に荷電し、クーロンカの作用で集塵極をかねた対向電極6,6′上に分離捕集する。この方式の特徴は非コロナ第３電極47を用いているため、これとコロナ放電極8,8′との距離を充分小さく選定でき、高圧極短パルス電源の出力パルス電圧の値を比較的低くしても両電極間に本発明の脱硝・脱硫のための電界値条件を満

足する高い電界を容易に形成できる点にある。勿論この場合負コロナの一部はコロナ放電極8,8′より対向電極6,6′に向っても進展し、バイアス直流高圧電源15の出力電圧を充分高くしておくと、コロナ放電極8,8′と対向電極6,6′との間のガス通路19においても脱硝・脱硫反応が行なわれる。尚スイッチ51を投入したまま二連切替スイッチ52を右に投入すると、高圧極短パルス電源18よりケーブル17を介して供給される極短パルス高電圧は結合コンデンサー60′,60を介して導線57,58に印加されるので、該高圧極短パルス電源18は絶縁の必要がなくなり、また高圧同軸ケーブル17の外皮55も接地することが出来る。スイッチ51をオフするとバイアス直流高電圧がコロナ放電極8,8′と非コロナ第三電極にかからなくなり、脱硝・脱硫作用は存続するが、電気集塵作用は消失する。

第８図は本発明のいま一つの実施例の縦断面図で、第７図において非コロナ第三電極47の代りに線状コロナ放電極61,61′,61″より成るコロナ第三電極62を上下の水平支持導体27,28に固定張架して用い、61−61′,61′−61″の中間に線状のコロナ放電極8,8′を上方においては上部水平支持導体27を貫通する碍管31,31′，下方においては下部水平支持導体28に固定された絶縁物29,29′により張架して絶縁配設したものである。8,8′の上端は分配用共通導体37に接続され碍管38,導線57,二連切替スイッチ52を介して絶縁された高圧極短パルス電源18の正の出力端子に接続された高圧同軸ケーブル17の心線56に接続されている。また上部水平支持導体27はその右端において金属支柱12,導線58,スイッチ51,塞流インダクタンス14を介してバイアス直流高圧電源15の正の出力端子と接続され、更に二連切替スイッチ52を介して上記高圧同軸ケーブル17の絶縁された導体外皮55に接続されている。したがって線状コロナ放電極8,8′には常時は高抵抗54を介して、線状コロナ第三電極61,61′,61″と同様に，接地対向電極6,6′に対して正のバイアス直流高電圧が印加されており、これに重ねて極短パルス高電圧が8,8′を61,61′,61″に対して正極性とする如き極性をもってコロナ放電極8,8′に印加される。この場合には極短パルス高電圧の急峻な波頭部が上から下に向って伝播する過程でまず61,61′から８に向って、また61′,61″から８′に向って負のストリーマー状コロナ放電が生じ、これに誘発されて８から61,61′及び6,6′に向って、また８′から61′,61″及び6,6′に向って強力な正のストリーマー状コロナ放電が生じて両コロナ放電極間及びコロナ放電極8,8′と対向電極6,6′間のガス通路19を橋絡し、排ガスの脱硝・脱硫を行なう。この場合8,8′の長さは約6mで、下端がピーキング作用のある開放端となっているので、すでに述べた理由で正コロナ放電に伴なう極短パルス高電圧波高部の著しい欠損にも拘らず、ほぼ6mの全長にわたって均一な正負コロナ放電を生ずる。本例の様に第三電極をもコロナ放電極とする時の利点は、（１）第三電極61,61′,61″からの先駆負コロナ放電による放電化学的脱硝・脱硫作用が加わること、（２）このストリーマー状先駆負コロナ放電による衝突電離と光電離作用により予め両コロナ電極間及びガス通路19に電子が生成され、その上コロナ放電極8,8′近傍まで伸展した負コロナストリーマーは、8,8′の前面に強力な電子空間電荷電界を生ずるので、次の瞬間8,8′から正ずる正のストリーマーコロナ放電が極めて安定かつ強力となり、脱硝・脱硫作用がより有効に発揮されるという点にある。二連切替スイッチ52を右に倒せば高圧極短パルス電源18を絶縁する必要がなくなることは第７図の実施例と同様であり、またスイッチ51をオフすると正のバイアス直流高電圧が8,8′,61,61′,61″に印加されなくなるのでガス通路に直流バイアス電界がなくなり、極短パルス高電圧印加時における8,8′から6,6′への正のストリーマーコロナ放電の進展が弱まり、脱硝・脱硫効果が減ずるが、集塵効果があらわれる。

第９図は対向電極自体もコロナ放電極とした二電極式のコロナ電極系をもって本発明を実施せるものの一例である。図において63,64はそれぞれ矩形断面を有する素線２本より成る所の二重らせん電極で、それぞれ上下端においてケーシング１の天井65に固定された二重らせん溝を有する支持碍子66,67,水平ビーム９に固定された二重らせん溝を有する支持碍子68,69のらせん溝にねじ込まれて絶縁張架されている。そして63,64の二本の素線70−71,72−73は下端において接続導線74,75により互いに接続されており、これにより63,64は直列接続されて一つの終端開放のコロナ伝送線路を形成している。そしてその入力端79は導線76,77,碍管７を介して高圧同軸ケーブル17の心線56及び接地された導体外皮55に接続され、これによって高圧極短パルス電源18に接続されている。いま上記入力端79に印加された極短パルス高電圧は進行波として二重らせん電極63の二本の素線70,71に沿って下方に伝播し、次いで74,75を介して二重らせん電極64の下端に移り、その素線72,73に沿って上方に伝播し、その開放終端80に至り、ここで全反射されてピーキングが行われる。この管に63の素線70,71及び64の素線72,73の全体に沿って両方の素線から相手素線に向って強力な負のストリーマー状コロナ放電と、両素線間を橋絡する強力な正のストリーマー状コロナ放電を発生し、アンモニアガスを添加の上入口２より導入された排ガスの脱硝と脱硫を行う。浄化されたガスは出口３より集塵装置を介して硫安ダストを除去のうえスタックへと排出される。40,40′は天井６にとりつけた槌打装置で、二重らせん電極の素線上に付着堆積する硫安ダストを槌打衝撃によって下方のホッパー４に落下せしめ、排出口５より外部に排出する。本例の特徴は両素子とも線状コロナ放電極たる二重らせん電極を使用したことで、すでに述べた如き負コロナと正コロナの協同的相乗作用によって脱硝・脱硫効果を高め、更に電極の空間装荷率

を向上でき、かつ多数本の電極を容易に取り付けうるという構造上の利点が大きい。

第10図（ａ）は本発明に利用する極めて巾の短いパルス高電圧を発生する為の高圧パルス電源の一回路方式を示す。図において81は低圧主電源で昇圧変圧器82の一次側に接続されて交番主電圧を供給し、その二次側に波高値150KVの交流高電圧を発生、これが半波整流器83,保護抵抗84,塞流インダクタンス85を介してタンクコンデンサー86を負の150KVに充電する。この場合はタンクコンデンサー86は交流電圧によりゼロ電圧からピーク電圧迄充電されるので、充電に伴う回路損失は交流充電特有の極めて小さな値に止る。この充電半周期の期間内には、該タンクコンデンサー86の一端と、高圧同軸ケーブル17の一端に接続された固定火花電極87,88に介在する回転火花スイッチ89の大地から絶縁された回転子90に90度の角度をもって固定された回転火花電極91,92,93,94はいづれも87,88から充分の離隔距離をもって遠ざかっており、この部分に火花が発生することはない。すなわちこの回転火花スイッチ89は、90度の角度をもって配置され互いに導通せる４個の火花電極91～94を有する大地から絶縁された回転子90と、これを上記二次側交流高電圧の周波数の同期して回転させる電動機で、丁度整流器83が導通状態にある半周期には回転火花電極91～94が固定火花電極87,88から離隔しており、次に交番主電圧の次の半サイクル、したがって昇圧変圧器82の二次側交番電圧の極性が反転し、整流器83が阻止状態になった半周期の期間内に二対の回転火花電極91－93,92－94のいづれか一対が順次に固定火花電極87,88に接近して火花を発生させる様に位相調整器95の作用で供給電圧の位相、したがって、回転位相を制御された同期電動機96より成る。いま回転火花スイッチ89が火花によりオンすると、タンクコンデンサー86の充電電圧が同軸ケーブル17のサージインピーダンスＺ。（純抵抗Ｒ）を通じて放電、そのCR放電波形が負の極短パルス高電圧の進行波として右方に伝播し、結合コンデンサー16を介して本発明による排ガス脱硝・脱硫装置97内に入り、予め負の直流バイアス高圧電源15により塞流インダクタンス14を介して負のバイアス直流高電圧を印加されている所のジグザグ状の長い線状コロナ放電極より成るコロナ伝送線路35に印加され、脱硝・脱硫・集塵作用を行う。

第10図（ｂ）は第10図（ａ）の例で、低圧交流主電源81が商用周波交流電源98と逆並列接続のサイリスター99,100の直列接続回路から成り、かつ半波整流器83の代りに全波整流器101を用いた本発明に使用すべき極短パルス高圧電源の例の回路方式を示し、他のすべての要素はサイリスター99,100の制御信号部102を除いて第10図（ａ）と同様である。本例では交流主電圧に同期してその半波毎の適当な位相時点で交互にサイリスター99,100に制御信号部102から制御信号を供給し、これを導通せしめる。制御信号部102からは更に導線103を介して別の制御信号が位相調整器95に送られ、これにより同期電動機96の回転位相を制御して、サイリスター99,100がオン状態にある時は回転火花スイッチ89の固定火花電極87,88と回転火花電極91～94が充分離隔していて火花を発生せず、サイリスター99,100がオフ状態の時にのみ上記火花電極が近接して火花を発生する様にしている。

第11図は第10図（ａ），（ｂ）のコロナ伝送線路35と対向電極6,6′の間に生ずる電圧Ｖの波形を示すもので、ｔは時間を示す。電圧波形は負のバイアス直流高電圧Vdに負の極短パルス高電圧が周期的に重畳したものとなる。したがって（Vd＋Vp）が両電極間のガス通路に加わる電圧の波高値（ピーク）値となり、パルス電源の出力電圧をVdの分だけ減らすことが出来て経済的となる。この場合負の極短パルス高電圧により発生した負イオンは、負のバイアス直流高電圧により対向電極6,6′へと駆動されるので、排ガス中のダストや脱硫による生じた硫安ダストを負イオンの射突で荷電する。そして上記バイアス直流高電圧によりガス通路に直流電界が存在するので、この電荷を帯びた粒子を対向電極6,6′に駆動・捕集するという電気集塵作用があらわれる。しかし集塵を目的とせず単に排ガスの脱硝・脱硫のみを目的とする場合、特に正の極短パルス高電圧を用いる場合（この場合装置容積を大幅に縮小出来る）にはバイアス直流高電圧を常時コロナ放電極に印加しておくと、イオンが直流電界により移動してイオン電流が流れ、これに伴ってかなりのエネルギー損失を生ずるので好ましくないこともある。この場合にはバイアス高電圧として直流電圧の代りに形成の容易な巾の広いバイアス・パルス高電圧を用いると、イオン電流による電力損失を大幅に低減できて好都合である。

第12図は本発明に用いるためのこの様なバイアス・パルス高電圧を併用した高圧極短パルス電源の一例である。104は高圧極短パルス電源で低圧主電源81,昇圧変圧器82,両波整流器101,減衰抵抗84,塞流インダクタンス85,結合コンデンサーを兼ねたパルス波形成形用コンデンサー105,漏洩抵抗106,及び固定火花電極107と接地された回転子89上にとりつけられた４個の回転火花電極91,92,93,94,その駆動用同期電動器96,その位相調整器95及びその制御信号部108が図示の如く結線，配設されたものより成る。また109はバイアス・パルス高電圧を発生するための高圧バイアス・パルス電源で、低圧商用周波数電源110,昇圧変圧器111,両波整流器112,減衰抵抗113,塞流インダクタンス114,タンクコンデンサー115,サイリスタースイッチ素子116,これと逆並列に接続された整流器118,スイッチ素子116の制御信号部108,共振用インダクタンス117,整流器118と直列の小さな保護インダクタンス119,残留電圧リセット用サイリスタースイッチ120,その制御信号部108,120の保護抵抗121,切替スイッチ122及び123,昇圧用パルス変圧器124,小さな保護インダクタンス125,高圧導線126,127,128及び接地導線129,出力端

子130,131が図示の如く結線，配設されたものより成る。高圧極短パルス電源104の出力端子132,133は分離用伝送線路を兼ねたケーブル17の入力端で、その心線56と導体外皮55に接続され、ケーブル17の出力端では心線56は脱硝・脱硫装置97のコロナ放電極群８に、また導体外皮55は接地された対向電極群6,6′に接続されている。またバイアス・パルス高圧電源109の出力端子130,131はそれぞれ高圧極短パルス電源104の出力端子132,133に図の如く接続されている。いま切替スイッチ122,123が図示の如く投入されている時はパルス変圧器124は切り離されている。先づ低圧主電源81の出力電圧がゼロ値付近の値をとる時その信号が導線134を介して制御信号部108に伝えられ、ここからトリガー用制御信号が導線135を介してサイリスター116の制御グリッドに与えられ、116がオンする。これにより充分に大きな静電容量Coを有するタンクコンデンサー115の正の直流高電圧がインダクタンス値Ｌの共振用インダクタンス117,導線126及び127,保護インダクタンス125,出力端子130,132及び導線129,出力端子131及び133を介し、更にケーブル17を介して脱硝・脱硫装置97のコロナ放電極群８と対向電極群6,6′の間に印加され、その電極間静電容量C1をコンデンサー115の充電電圧Voのほぼ２倍近くの電圧（波高値）＋Vpoまで117のＬとC1との過渡振動によって共振充電する。但しCo≫C1としてある。次に同じくＬとC1の過渡振動によってC1の電圧Vpoが共振インダクタンス117,整流器118,保護インダクタンス119を介してタンクコンデンサー115のCoに向って放電し、この一周期の過程でコロナ放電極群８と対向電極群6,6′の間にその巾がＬとC1で定まる巾の広い波高値Vpoの正のバイアスパルス高電圧が印加される。但し回路損失のため常に端子130,131間には直流小電圧Vrが残留し、これを放置すると、これが累積してＬとC1による過渡振動自体が起きなくなるので、一周期の終りに108からトリガー信号が導線136を介してリセット用サイリスタースイッチ120に与えられてこれをオンし、残留電圧が小さな保護抵抗121,及び該サイリスター120を介して放電する。この場合切替スイッチ122,123をそれぞれ反対方向に投入すると、このリセット用サイリスタースイッチ120が切り離され、パルス変圧器124が接続され、上記バイアス・パルス高電圧の昇圧が行なわれると共に該残留電圧Vrはパルス変圧器124の二次巻線を介して放電されるが、パルス変圧器の損失が加わる。さて上記バイアス・パルス高電圧がその波高値Vpoに達した時、108からの信号で制御された位相調整器95でその回転位相を制御せる回転式火花スイッチ89のスリップリング137を介して接地された回転子導体90上に90の回転角をもって配置された回転火花電極91～94のいづれかが固定火花電極107に接近して火花を生じ、結合コンデンサーを兼ねた静電容量Ｃのパルス波形成形用コンデンサー105の充電電圧を、該回転火花スイッチ89,分離用伝送線路を兼ねた高圧同軸ケーブル17のサージインピーダンスZo（＝Ｒ）を通して放電し、その際のCR放電で生じた巾の極めて短い波高値Vpoの正の極短パルス高電圧が進行波としてケーブル17上を右に伝播し、かかる急峻なパルスを通さないインダクタンス125の阻止作用で上記バイアスパルス高電圧の波高値Vpoに第13図に示す様に重畳してコロナ放電極群８と対向電極群6,6′間に印加され、前記重畳した電圧（Vpo＋Vp）における距離的平均電界強度がガス間隙に形成され有効な脱硝・脱硫作用を著しく高い電力効率をもって達成する。

第14図（ａ）は本発明に用いるための極短パルス高電圧を発生する為の高圧極短パルス電源のいま一つの回路方式を示す。図において６より106に至る要素の名称と機能は第10図（ａ）、（ｂ）における同一番号の要素のそれと同じである。しかし本例ではパルス成形用の容量性エネルギー貯蓄要素としてコンデンサー86の代りに高圧同軸ケーブル17自身を使用してコスト低減をはかっており、その入力端138で心線16と導体外皮15の間の静電容量を正の高電圧に充電されたタンクコンデンサー86から減衰用小抵抗139、塞流インダクタンス140,141を介して充電する。次に該高圧同軸ケーブル17の心線側出力端142に導線143を介して回軸火花スイッチ89が接続されており、これがオンすると同軸ケーブル17の充電電圧が巾の短かい矩形波の正の進行波パルス高電圧として結合コンデンサー16を介して正のバイアス直流高圧電源15により与えられている正のバイアス直流高電圧に重畳して脱硝・脱硫装置97のコロナ放電極群８と対向電極群6,6′の間に印加され、脱硝脱硫反応を行う。切替スイッチ13を左に投入すると固定火花電極144,145が自爆型の固定火花スイッチ147を構成し抵抗139と同軸ケーブル17の静電容量で定まる時定数で立ち上る17の充電電圧が該火花スイッチ147の火花電圧をこえる度にここで火花が発生し、極短パルス高電圧が97の電極間に供給され脱硝脱硫反応が行なわれる。この極短パルス高電圧は反射されて逆方向に戻るが塞流インダクタンス140,141の阻止作用でそれ以上電源内部に進入することなく反射され、以下多重反射をくり返しつつ減衰する。

本例では容量性エネルギー蓄積要素として高圧同軸ケーブル17を用いているが、その代りに第14図（ｂ）に示す様に86a,86a′…とインダクタンス140a,140a′…を梯子型に接続して成る、LC梯子型エネルギー蓄積要素17aを用いることも出来る。

第15図は本発明に使用すべき高圧極短パルス電源のいま一つの回路方式を示すもので、第12図における接地回転火花スイッチの代りに固定火花電極107及び接地の可動式固定火花電極146よりなる自爆型固定式火花スイッチ147を用いたものである。出力電圧Voの正の直流高圧電源148と出力電圧－Vbの負のバイアス直流高圧電源15により減衰抵抗84、塞流インダクタンス140および14を介して結合コンデンサーを兼ねたパルス波形成形用コンデンサー105が図示の極性でVo＋Vbの電圧に充電され

る。その充電電圧が火花スイッチ147の火花発生電圧をこえると自爆的に火花電極107,146の間に火花が発生し、該コンデンサー105の一方の端子149の電位は瞬時に大地電位となり、他方の端子150は－（Vo＋Vb）となり、すでに－Vbのバイアス直流高電圧を与えられている脱硝・脱硫装置97のコロナ伝送線路35に対して－Voの電圧が加わる。次の瞬間コンデンサー105が電源148と15により105の静電容量と84の抵抗で定まる時定数で再び充電されて元の状態に復し、火花スイッチ147が再びオンし以下この動作がつづく。この過程で－Voは上記時定数でCR減衰し、そのCR減衰電圧波形が、所要の極短パルス高電圧となる。この場合火花電極107,146の消耗に伴い両者の間隔が変化し、これに起因して火花スイッチ147の火花電圧が上昇し、パルス電圧の上昇とその周波数低下を生ずるので分圧器151,152により火花電圧を検出の上これを火花電圧制御装置153に入力し、火花電圧が一定となる様に火花電極146を把持した操作部154を上方に制御駆動し、火花間隔をコントロールして火花電圧を一定に保つ様にする。

本発明によるガス浄化装置を実際の排ガス浄化プロセスに使用するには、多種多様の使用形態がある。第16図の（ａ）～（ｅ）はそのいくつかの例を示すものである。斜線を施した部分155が本発明によるガス浄化装置ある。同図（ａ）は正のパルス高電圧を用いた本装置155を排ガスダクトの途中に設置し、その上流側ダクト156の内の排ガス中たとえばアンモニア等の適当な添加剤を注入するめの容器20,注入管21,注入ノズル22より成る添加剤注入装置157を設けたものである。同図（ｂ）は更にその上流側に排ガスを冷却して温度を下で脱硝脱硫等のガス浄化効率を向上せしめるためのガス冷却塔158を、また下流側に硫安塔の生成微粒子を捕集するためのバグフイルター、スクラッバー、ないしNO2、SO2等の水溶性のガス状反応生成物を水・NaOH水溶液・Na2CO3水溶液あるいは石灰乳等の吸収剤で除去するためのスクラッバー等、適当な後処理装置159を設けたもので160はスタックである。同図（ｃ）は三個の集塵室161,162,163より成る電気集塵装置164の上流側集塵室161と、入口ダクト156内に本発明によるガス浄化装置155,155′を設けたもので、155,155′にはそれぞれ正の極短パルス高電圧を用いて短い滞留時間内に脱硝脱硫等のガス浄化反応を完了し、硫安等の生成微粒子を排ガス中のダストと共に集塵室162、163で電気集塵するものである。同図（ｄ）は図（ｃ）ですべての集塵室161～163に負の極短パルス高電圧を負の直流バイアス高電圧に重ねて用い、本発明によるガス浄化と電気集塵装置自体の負パルス荷電による集塵とを併わせ行うものである。同図（ｅ）は従来の湿式スクラッバー方式による排ガス脱硫装置、バグフィルター、電気集塵装置等の適当な前処理装置165のあとに本発明によるガス浄化装置155をとりつけたものである。

尚本発明はたとえば集塵用円筒型バグフィルター内部に線状コロナ放電極を設けた如き加電式バグフィルターにおいて、該線状コロナ放電極に極短パルス高電圧を直接ないし結合コンデンサーを介しバイアス直流高電圧に重ねて印加することにより実施してもよいことも云うまでもない。

［発明の効果］

本発明は触媒、スクラッバー、電子ビーム等設備費、運転費が高く保守の面倒な装置を用いることなく、完全に乾式で極短パルス高電圧によるコロナ放電の放電化学作用によって排ガスの脱硝と脱硫を同時に且つ有効に行う。したがって装置の腐蝕もなく、保守も容易で設備費、運転費共に安い。また単に脱硝、脱硫のみでなく、負コロナ放電の利用により排ガス中のダストの電気集塵も同じ装置内で行うことが出来るので、好適である。

【図面の簡単な説明】

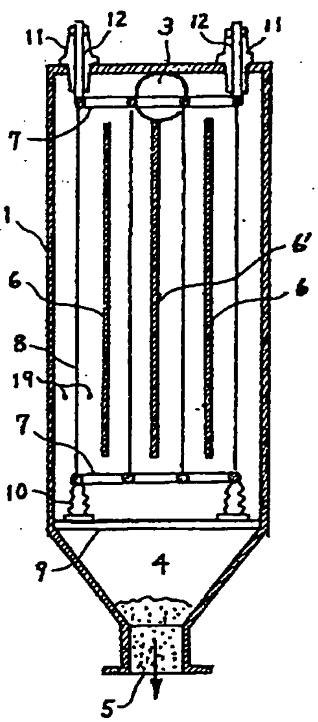
第１図は本発明による排ガス脱硝・脱硫装置の一実施例の縦断面図、第２図はその横断面図である。第３図、第４図、第５図、第６図（ａ）、第６図（ｂ）、第７図、第８図、および第９図、はそれぞれ本発明の異った実施例の縦断面図を示す。第10図（ａ）、第10図（ｂ）はそれぞれ本発明に用いる高圧極短パルス電源の異なった回路方式を示し、第11図はこれらの電源で得られる電圧波形を示す。第12図は本発明に用いる高圧極短パルス電源のいま一つの回路方式を示し、第13図はこれにより得られる電圧波形を示す。第14図（ａ）および第15図はそれぞれ本発明に用いる別の高圧極短パルス電源の異なった回路方式を示す。第14図（ｂ）はLC梯子型エネルギー蓄積要素の回路図を示す。第16図（ａ）、第16図（ｂ）、第16図（ｃ）、第16図（ｄ）、および第16図（ｅ）は本発明によるガス浄化装置をプロセスの系統内に設置して使用する場合のそれぞれ異なった設置・使用形態を示す。

図における主要要素の名称を記すと下記の通りである。

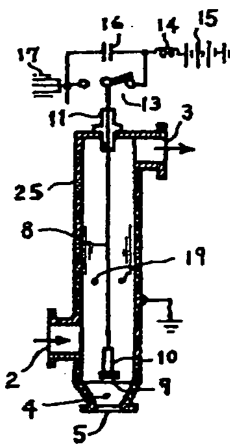
１……ケーシング
２……ガス入口
３……ガス出口
４……ホッパー
５……ダスト排出口
6,6′……対向電極ないし集塵極
8,8′……コロナ放電極
8a,8a′……ピーキング放電極
13,51,122,123……切替スイッチ
15……バイアス直流高圧電源
16,60,60′,105……結合コンデンサー
17……ケーブル
17a……LC梯子型エネルギー蓄積要素
18……高圧極短パルス電源
19……ガス通路
22……アンモニアガス注入口

23,156……入口ダクト
33,34……ピーキングコイル
35……コロナ伝送線路
40,41……槌打装置
48,48′,48″……垂直導体柱第三電極
52……二連切替スイッチ
61,61′,61″……線状コロナ放電極としての第三電極
81,110……低圧交流主電源
82,111……昇圧変圧器
83,118……半波整流器
85……塞流インダクタンス
86,86a,86a′,115,140,141……タンクコンデンサ
89……回転火花スイッチ
95……位相調整器
96……同期電動器
99,100,116,120……サイリスタ
101,112……両波整流器
＊102……制御信号部
117……共振インダクタンス
124……パルス変圧器
140,141,140a,140a′……インダクタンス
147……自爆型固定式火花スイッチ
148……高圧直流電源
151,152……分圧抵抗
153……火花電圧制御部
154……操作部
155,155′……ガス浄化装置
157……添加剤注入装置
158……ガス冷却塔
159……後処理装置
160……スタック
161,162,163……集塵室
164……電気集塵装置
＊165……前処理装置

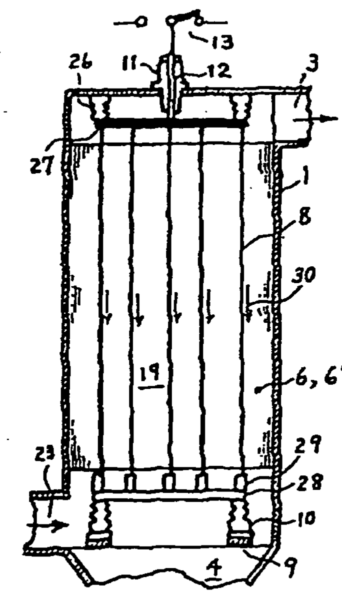
【第２図】



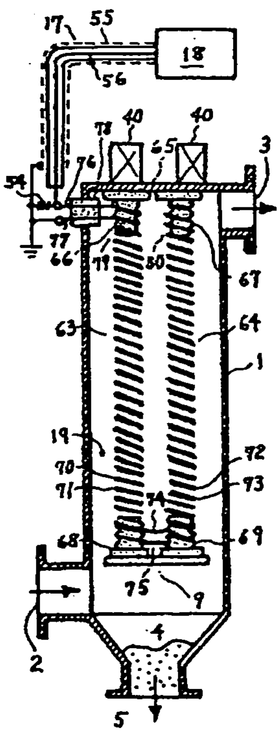
【第３図】



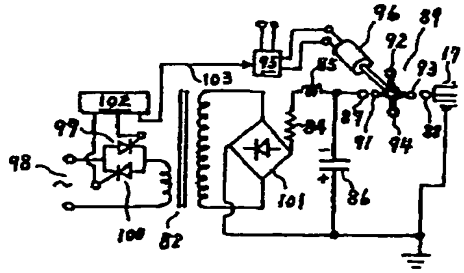
【第４図】



【第９図】

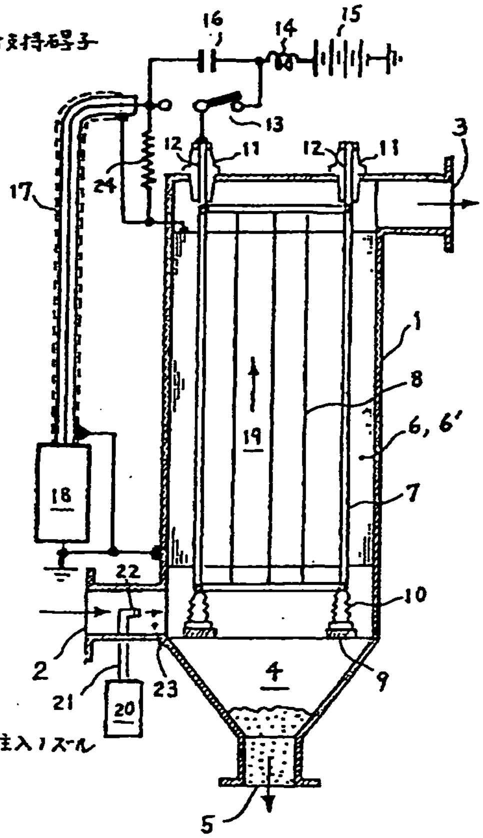


【第１０図（ｂ）】

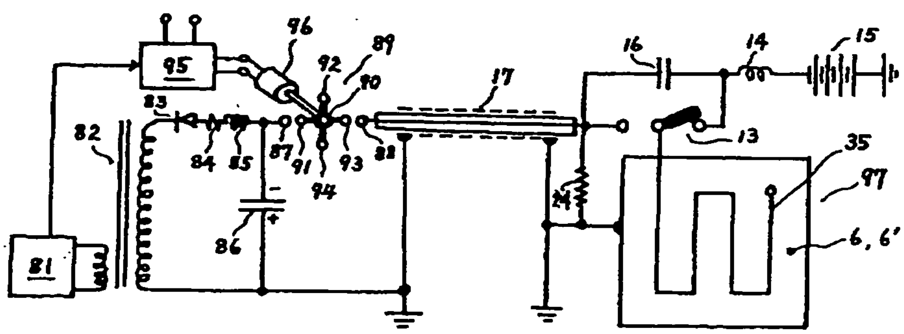


【第１図】

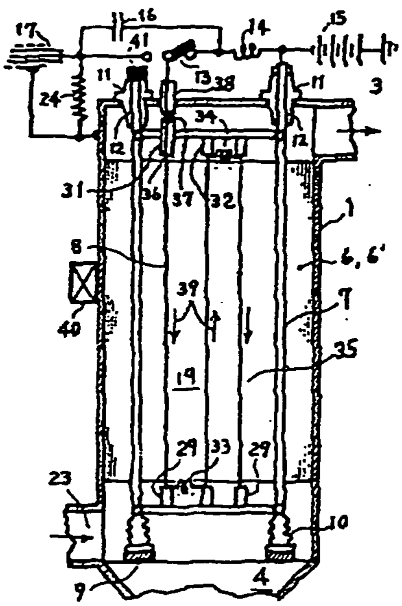
1----ケーシング
2----ガス入口
3----ガス出口
4----ホッパー
5----ダスト排出口
6,6'----対向電極又は集塵極
7----金属支持枠
8,8',8"----コロナ放電極
9----水平ビーム
10----支持碍子
11----碍管
12----金属支柱
13----切替スイッチ
14----塞流インダクタンス
15----バイアス直流高圧電源
16----結合コンデンサー
17----高圧同軸ケーブル
18----高圧極短パルス電源
19----ガス通路
20----アンモニア容器, 21----同注入パイプ, 22----同注入ノズル
25----円筒対向電極
23----入口ダクト
40----槌打装置
54----漏電用抵抗
55----ケーブル導体外皮
56----ケーブル心線
63,64----二重らせん電極
65----ケーシング天井
66,67 68,69----らせん溝付支持碍子
70,71 72,73----素線
74,75----接続導線
76,77----導線
78----碍管
79----入力端
80----終端



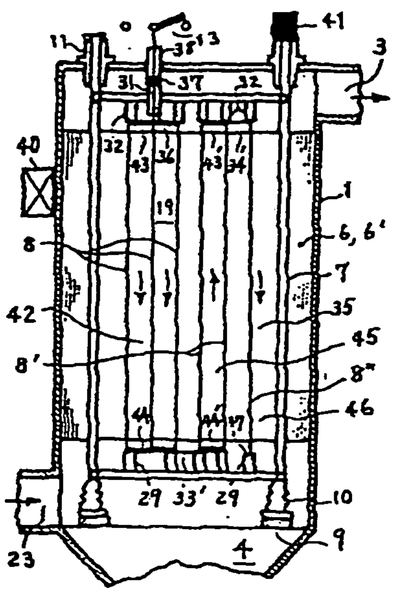
【第１０図（ａ）】



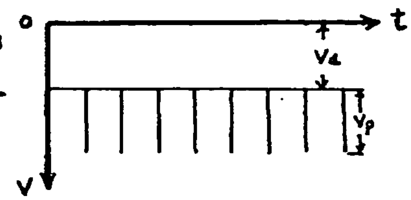
【第５図】



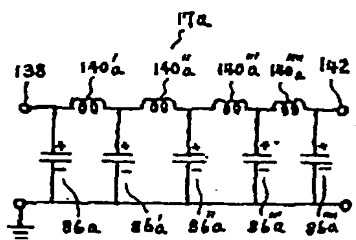
【第６図（ａ）】



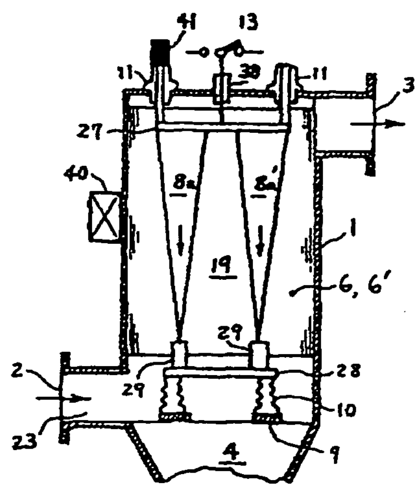
【第１１図】



【第１４図（ｂ）】

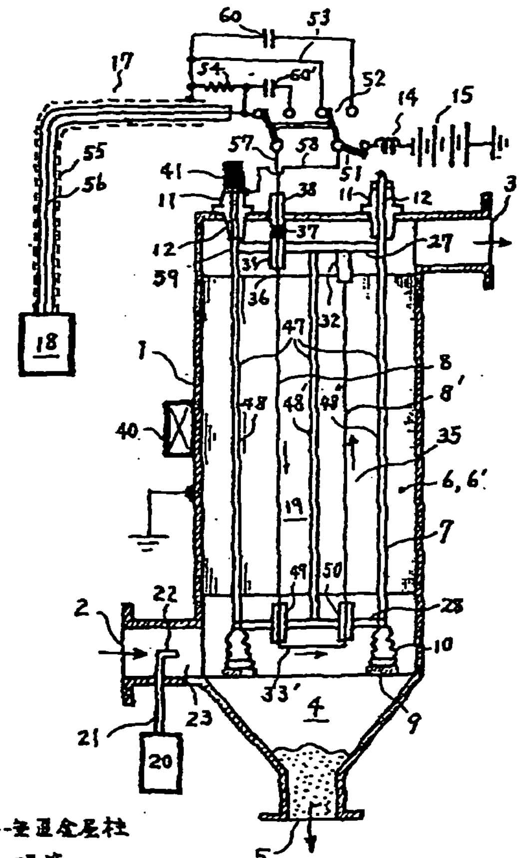


【第６図（ｂ）】



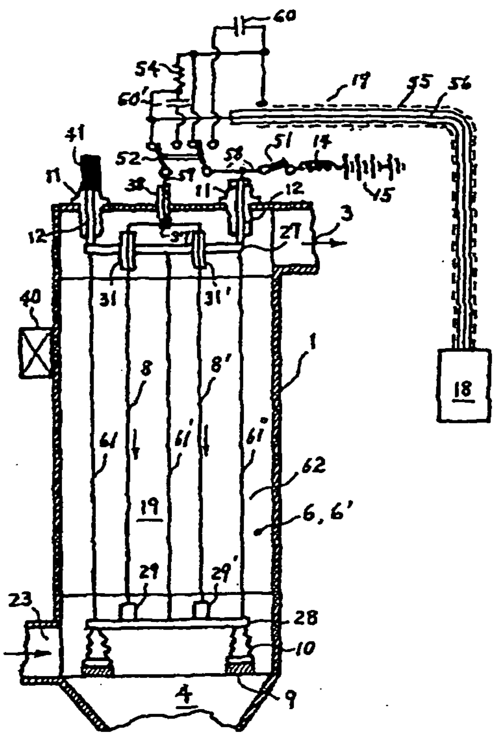
26-----上部支持碍子
27-----上部水平支持導体
28-----下部水平支持導体
29----絶縁物
30-----矢印
31,31'---碍管
32-----絶縁物
33,34---ピーキング用コイル
35-----コロナ伝送線路
36------入力端
37-----共通導体
38-----碍管
39-----矢印
40,41---槌打装置
42-----第1段線状コロナ放電極群
43,43', 44,44'---水平支持導体
33',34'--接続導線
45-----第2段線状コロナ放電極群
46-----第3段線状コロナ放電極
8a,8a'--ピーキング放電極

【第７図】

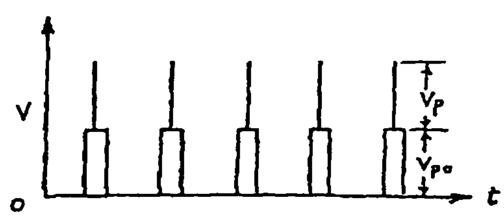


48,48',48"---垂直金属柱
49,50-----碍管
51--------切替スイッチ
52---------2連切替スイッチ
53,57,58---導線
54--------漏電用抵抗
55--------高圧同軸ケーブル導体外皮
56---------全上心線
60,60'-----結合コンデンサー
61,61',61"---線状コロナ放電極としての第2電極
59--------左上端
62---------コロナ第2電極

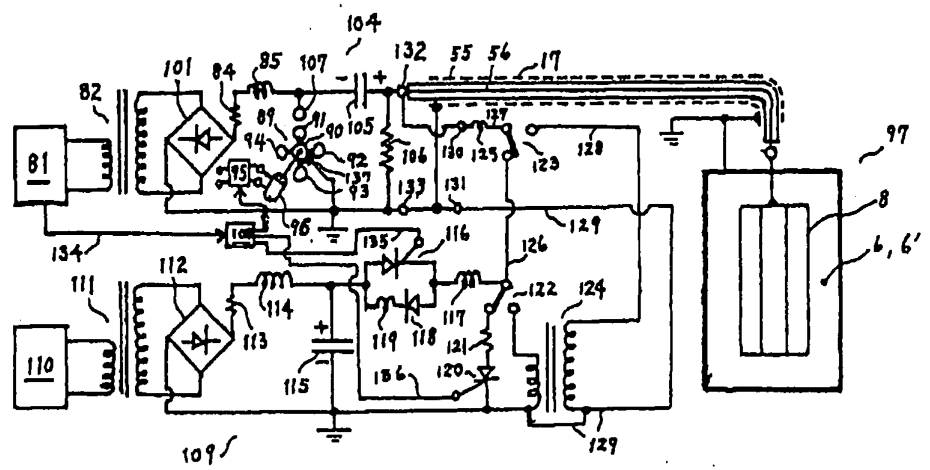
【第８図】



【第１３図】



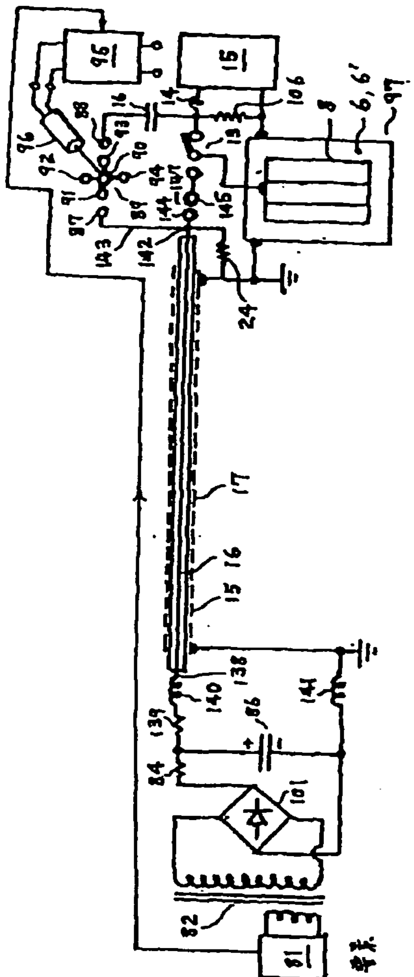
【第12図】



81,110 ------低圧交流主電源.
82,111 ------昇圧変圧器
83 ------半波整流器
84,113,121 ---保護抵抗
85,114,125 ---塞流インダクタンス
86,115 ------タンクコンデンサー
87,88 ------固定火花電極
89 ------回転火花スイッチ
90 ------回転子
91,92 93,94 } ----回転火花電極
95 ------位相調整器
96 ------同期電動機
97 ------脱硝・脱硫装置
98 ------商用周波低圧交流主電源.
99,100,116 ---サイリスター
101,112 ------全波整流器
102 ------制御信号部
103 ------導線
104 ------高圧極短パルス電源
105 ------結合コンデンサー
106 ------漏洩用抵抗
107 ------固定火花電極
108 ------制御信号部
109 ------巾の広い高圧パルス電源.(バイアス・パルス高圧電源)
118 ------整流器
119 ------保護インダクタンス
117 ------共振インダクタンス

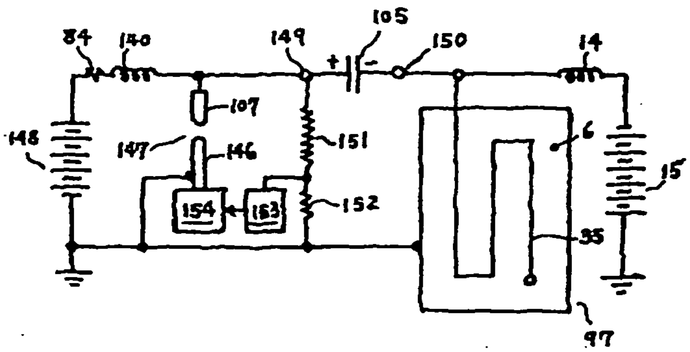
120 ------リセット用サイリスター
122,123 ------切替スイッチ
124 ------パルス変圧器
126,127,128 135,136,134 } --導線
129 ------接地導線
130,131, 132,133 } ---出力端子
137 ------スリップリング

【第１４図（ａ）】

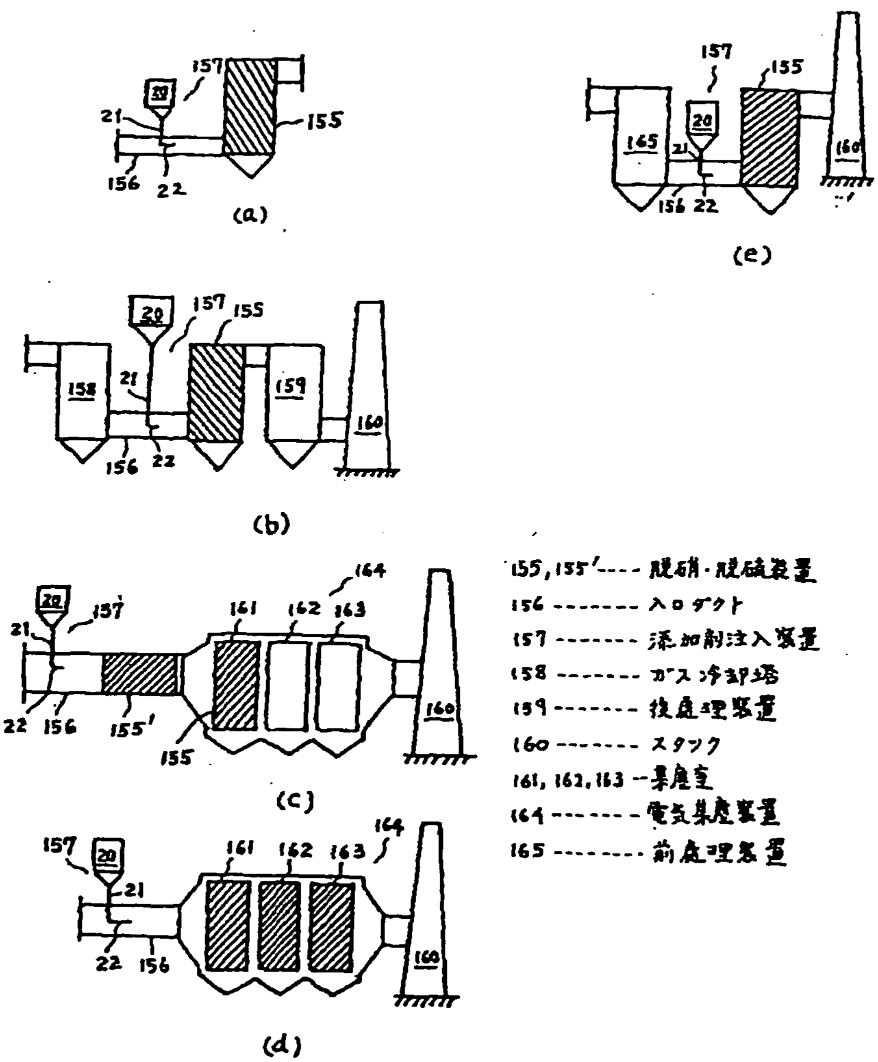


138………入力端
140,141……整流インダクタンス
139……減衰抵抗
142……出力端
143……導線
144,145,107…固定火花電極
146……可動式固定火花電極
147……自爆型固定火花スイッチ
148……高圧直流電源
149,150……端子
151,152……分圧抵抗
153……火花電圧制御装置
154……操作部
17a……LC梯子型エネルギー蓄積要素
86a,86a'…コンデンサー
140a,140a'…インダクタンス

【第１５図】


84
140
149
105
150
14
107
148
147
146
151
6
15
154
163
152
35
97

【第１６図】


(a)
(b)
(c)
(d)
(e)
155,155'---- 脱硝・脱硫装置
156 -------- 入口ダクト
157 -------- 添加剤注入装置
158 -------- ガス冷却塔
159 -------- 後処理装置
160 -------- スタック
161,162,163 -- 集塵室
164 -------- 電気集塵装置
165 -------- 前処理装置